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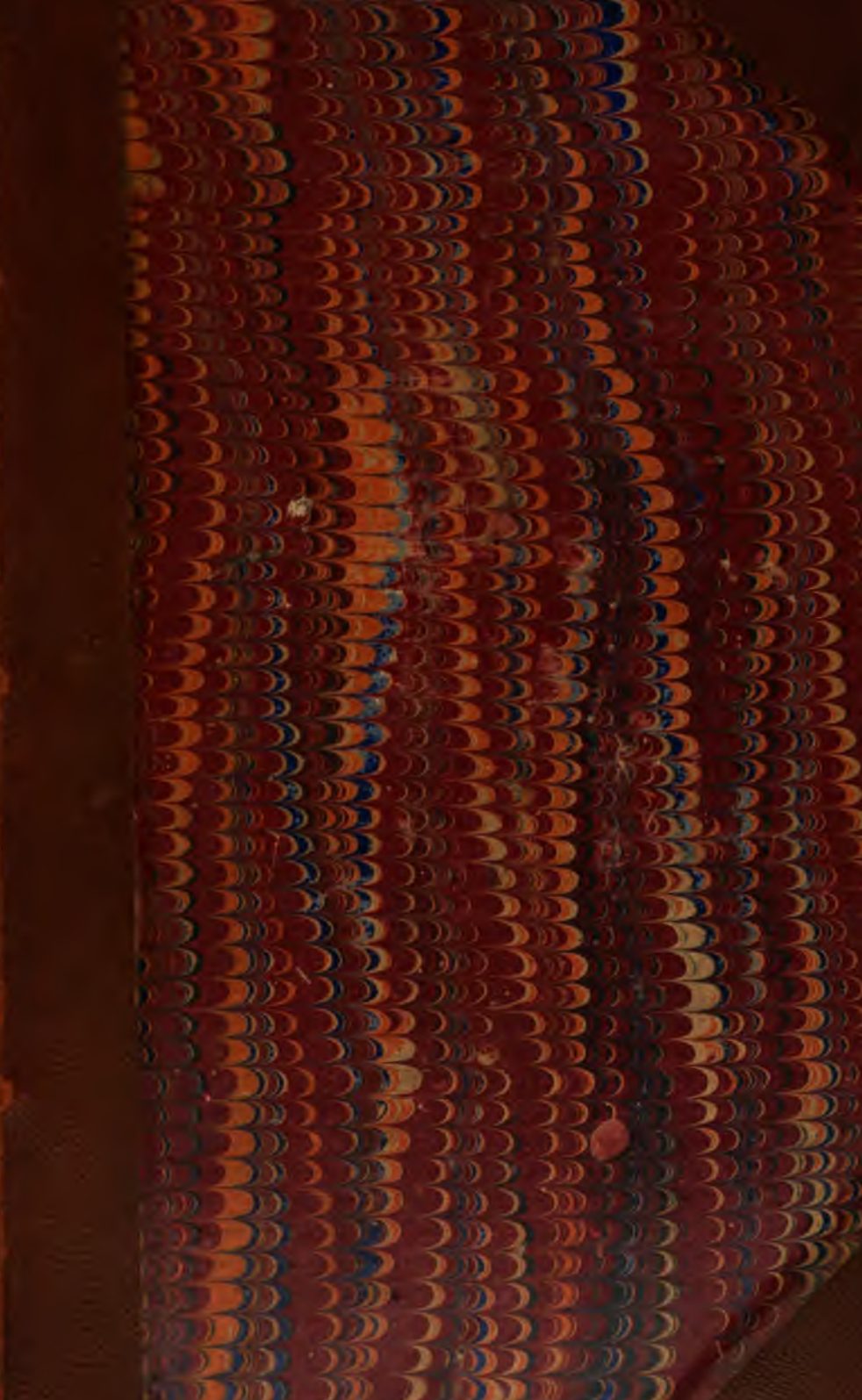

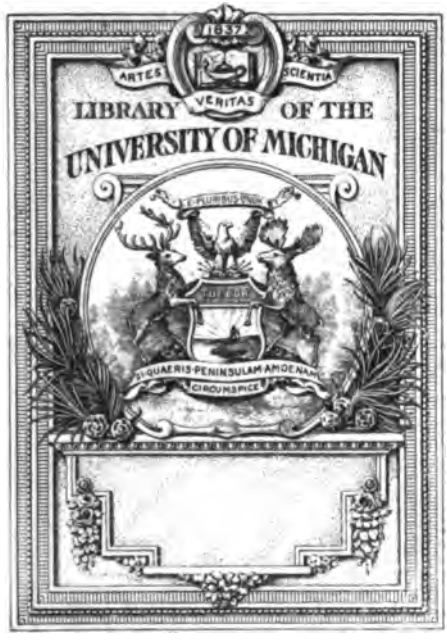

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LORD BACON'S WORKS.

VOLUME THE FOURTH.

CONTAINING

SYLVA SYLVARUM:

OR, A NATURAL HISTORY.

IN TEN CENTURIES.

Vansomer pinx^t W. H. Worthington sc.

Fr. Verulam Cano

Published by William Pickering, Chancery Lane, London 1826

THE WORKS

OF

FRANCIS BACON,

Lord Chancellor of England.

A NEW EDITION:

BY

BASIL MONTAGU, ESQ.

VOL. IV.

LONDON:
WILLIAM PICKERING.
MDCCCXXVI.

Thomas White, Printer,
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TO

THE READER.

HAVING had the honour to be continually with my lord in compiling of this work, and to be employed therein, I have thought it not amiss, with his lordship's good leave and liking, for the better satisfaction of those that shall read it, to make known somewhat of his lordship's intentions touching the ordering, and publishing of the same. I have heard his lordship often say, that if he should have served the glory of his own name, he had been better not to have published this Natural History: for it may seem an indigested heap of particulars, and cannot have that lustre, which books cast into methods have; but that he resolved to prefer the good of men, and that which might best secure it, before any thing that might have relation to himself. And he knew well, that there was no other way open to unloose men's minds, being bound, and, as it were, maleficiate, by the charms of deceiving notions and theories, and thereby made impotent for generation of works, but only no where to depart from the sense, and clear experience, but to keep close to it, especially in the beginning: besides, this Natural

History was a debt of his, being designed and set down for a third part of the Instauration. I have also heard his lordship discourse that men, no doubt, will think many of the experiments, contained in this collection, to be vulgar and trivial, mean and sordid, curious and fruitless: and therefore, he wisheth that they would have perpetually before their eyes what is now in doing, and the difference between this Natural History and others. For those Natural Histories which are extant, being gathered for delight and use, are full of pleasant descriptions and pictures, and affect and seek after admiration, rarities, and secrets. But, contrariwise, the scope which his lordship intendeth, is to write such a Natural History, as may be fundamental to the erecting and building of a true philosophy, for the illumination of the understanding, the extracting of axioms, and the producing of many noble works and effects. For he hopeth by this means to acquit himself of that for which he taketh himself in a sort bound, and that is, the advancement of all learning and sciences. For, having in this present work collected the materials for the building, and in his Novum Organum, of which his lordship is yet to publish a second part, set down the instruments and directions for the work; men shall now be wanting to themselves, if they raise not knowledge to that perfection whereof the nature of mortal men is capable. And in this behalf, I have heard his lordship speak complainingly, that his lordship, who thinketh he deserveth to be an architect in this

building, should be forced to be a workman, and a labourer, and to dig the clay, and burn the brick; and, more than that, according to the hard condition of the Israelites at the latter end, to gather the straw and stubble, over all the fields, to burn the bricks withal. For he knoweth, that except he do it, nothing will be done: men are so set to despise the means of their own good. And as for the baseness of many of the experiments; as long as they be God's works, they are honourable enough. And for the vulgarness of them, true axioms must be drawn from plain experience and not from doubtful; and his lordship's course is to make wonders plain, and not plain things wonders; and that experience likewise must be broken and grinded, and not whole, or as it groweth. And for use; his lordship hath often in his mouth the two kinds of experiments; "experimenta fructifera," and "experimenta lucifera:" experiments of use, and experiments of light: and he reporteth himself, whether he were not a strange man, that should think that light hath no use, because it hath no matter. Further, his lordship thought good also to add unto many of the experiments themselves some gloss of the causes: that in the succeeding work of interpreting nature, and framing axioms, all things may be in more readiness. And for the causes herein by him assigned; his lordship persuadeth himself, they are far more certain than those that are rendered by others; not for any excellency of his own wit, as his lordship is wont

to say, but in respect of his continual conversation with nature, and experience. He did consider likewise, that by this addition of causes, men's minds, which make so much haste to find out the causes of things, would not think themselves utterly lost in a vast wood of experience, but stay upon these causes, such as they are, a little, till true axioms may be more fully discovered. I have heard his lordship say also, that one great reason, why he would not put these particulars into any exact method, though he that looketh attentively into them shall find that they have a secret order, was, because he conceived that other men would now think that they could do the like; and so go on with a further collection: which, if the method had been exact, many would have despaired to attain by imitation. As for his lordship's love of order, I can refer any man to his lordship's Latin book, De Augmentis Scientiarum; which, if my judgment be any thing, is written in the exactest order that I know any writing to be. I will conclude with an usual speech of his lordship's; That this work of his Natural History is the World as God made it, and not as men have made it; for that it hath nothing of imagination.

W. RAWLEY.

This epistle is the same, that should have been prefixed to this book, if his lordship had lived.

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PREFACE.

In the spring of 1626, Lord Bacon died. In the same year, Dr. Rawley, "his Lordship's first and last "chaplain," as he always proudly entitles himself, collected and published the different poems which were written to the memory of his honored master *. In the year 1627, he published the Sylva Sylvarum, with an address to the reader, explaining the intention of Lord Bacon in the compilation of this work, and the probable objections which might be made to the publication; that it was not methodical; and that many of the experiments would be deemed vulgar and trivial.

With respect to the want of method, although, to use the words of Dr. Rawley, "he that looketh "attentively into the work, shall find that they have a "secret order," yet knowing as he did the charms of symmetry in arrangement and beauty of style, and the necessity of adopting them to insure an immediate and favourable reception of abstruse works, Lord Bacon was never misled by the love of order: he did not worship this idol; but "as Hercules, when he

* It is a small 8vo, of which there is a copy in the British Museum.

" saw the image of Adonis, Venus' minion, in a temple,
" said in disdain, ' Nil sacri es ;' so there are none of
" Hercules' followers in learning, that is, the more
" severe and laborious sort of inquirers into truth,
" but will despise those delicacies and affectations, as
" indeed capable of no divineness."*

" No man was, for his own sake, less attached to
" system of ornament than Lord Bacon. A plain un-
" adorned style in aphorisms, in which the Novum
" Organum is written, is, he invariably states, the
" proper style for philosophy. In the midst of his
" own arrangement, in the Advancement of Learning,
" he says : ' The worst and most absurd sort of tri-
" ' flers are those who have pent the whole art into
" ' strict methods and narrow systems, which men
" ' commonly cry up for the sake of their regularity
" ' and style.' "

Again he says : " It is of great consequence to
" consider whether sciences should be delivered by
" way of aphorism or of method. Methodical
" delivery is more fit to win consent or belief;
" but less fit to point to action; for they carry a
" shew of demonstration in orb or circle, one part
" illuminating another; and therefore do more
" satisfy the understanding; but being that ac-
" tions in common course of life are dispersed,
" and not orderly digested, they do best agree with
" dispersed directions. Lastly, aphorisms repre-
" senting certain portions only, and as it were

* See vol. II. of this work, 32.

"fragments of sciences, invite others to contribute "and add something; whereas methodical delivery "carrying shew of a total and perfect knowledge "forthwith secureth men as if they were at the "furthest."

Again, "science is much injured by the over "early and peremptory reduction of knowledge into "arts and method; from which time commonly "sciences receive small or no augmentation. But as "young men, when they knit and shape perfectly, "do seldom grow to a further stature; so know- "ledge, while it is in aphorisms and observations, it "is in growth; but when it once is comprehended in "exact methods, it may perchance be further po- "lished and illustrated, and accommodated for use "and practice; but it increaseth no more in bulk "and substance."*

Again: "And as for the overmuch credit that "hath been given unto authors in sciences, in making "them dictators, that their words should stand, and "not consuls, to give advice; the damage is infinite "that sciences have received thereby, as the prin- "cipal cause that hath kept them low, at a stay, "without growth or advancement. For hence it "hath come, that in arts mechanical the first devisor "comes shortest, and time addeth and perfecteth; "but in sciences the first author goeth farthest, and "time leeseth and corrupteth. So, we see, artillery, "sailing, printing, and the like, were grossly ma- "naged at the first, and by time accommodated

* Vol. II. of this Work, 48. † Ibid. 203.

" and refined: but contrariwise, the philosophies and " sciences of Aristotle, Plato, Democritus, Hippo- " crates, Euclides, Archimedes, of most vigour at " the first, and by time degenerate and imbased; " whereof the reason is no other, but that in the " former many wits and industries have contributed " in one; and in the latter many wits and industries " have been spent about the wit of some one, whom " many times they have rather depraved than illus- " trated. For as water will not ascend higher than " the level of the first spring-head from whence it " descendeth, so knowledge derived from Aristotle, " and exempted from liberty of examination, will not " rise again higher than the knowledge of Aristotle." This was the reason why the Sylva Sylvarum was published in Aphorisms, as " he knew well, that there " was no other way open to unloose men's minds, " being bound, and, as it were, maleficiate, by the " charms of deceiving notions and theories, and " thereby made impotent for generation of works."

With respect to some of the experiments being vulgar and trivial, Lord Bacon says in the Novum Organum*, "Quod vero ad rerum utilitatem attinet, vel " etiam turpitudinem, quibus (ut ait Plinius) honos " præfandus est; eæ res, non minus quam latissimæ " et pretiosissimæ, in Historiam Naturalem recipi- " endæ sunt. Neque propterea polluitur Naturalis " Historia: Sol enim æque palatia et cloacas ingre- " ditur, neque tamen polluitur. Nos autem non " Capitolium aliquod aut Pyramidem hominum

* Article 113.

" superbiæ dedicamus aut condimus, sed Templum " sanctum ad exemplar mundi in intellectu humano " fundamus. Itaque exemplar sequimur. Nam " quicquid essentia dignum est, id etiam scientia " dignum; quæ est essentiæ imago. At vilia æque " substitunt ac lauta. Quinetiam, ut è quibusdam " putridis materiis, veluti Musco et Zibetho, ali- " quando optimi odores generantur; ita et ab instan- " tiis vilibus et sordidis, quandoque eximia lux et " informatio emanat. Verum de hoc nimis multa; " cum hoc genus fastidii sit plane puerile et effœmi- " natum."*

And again, " with relation to this contempt of " natural history, on account of its containing things " that are vulgar, ignoble, subtile, or useless in their " origins, we should here consider, as an oracle, the " saying of the poor woman to the haughty prince,

* " But for unpolite, or even sordid particulars, which as Pliny " observes, require an apology for being mentioned; even these " ought to be received into a Natural History, no less than the " most rich and delicate; for Natural History is not defiled by " them, any more than the sun, by shining alike upon the palace " and the privy. And we do not endeavour to build a Capitol, or " erect a pyramid, to the glory of mankind; but to found a " temple, in imitation of the world, and consecrate it to the " human understanding: so that we must frame our model ac- " cordingly. For whatever is worthy of existence, is worthy of " our knowledge, which is the image of existence: but ignoble " things exist, as well as the noble. Nay, as some excremen- " titious matters, for example, musk, civet, &c. sometimes " produce excellent odours; so sordid instances sometimes " afford great light and information. But enough of this; as " such a delicacy is perfectly childish and effeminate."

" who rejected her petition as a thing below his " dignity to take notice of; then cease to reign; for " it is certain, that whoever will not attend to mat- " ters of this kind, as if they were too minute or " trifling, shall never obtain command or rule over " nature."

These two objections stated by Rawley were anticipated by Lord Bacon in the Novum Organum,* where he mentions a third objection which is, even at this day, repeatedly urged against the Sylva Sylvarum. " Some" he says, " without doubt, upon " reading our history and tables of invention, will " meet with experiments not well verified, or even " absolutely false,; and may thence, perhaps, be apt " to suspect, that our inventions are built upon " doubtful principles, and erroneous foundations. " But this is nothing: for such slips must necessarily " happen in the beginning. It is but as if here and " there a letter should be misplaced, or mistaken, in " a writing, or printed book; which does not, " usually, much interrupt the reader: as such errors " are easily corrected, from the sense of the place. " In the same manner let men observe, that expe- " riments may be falsely believed, and received in " natural history; and yet soon after be expunged " and rejected, when causes and axioms are disco- " vered. Though, it is true, that if there should " be many, and frequent, and continued errors, " in a natural and experimental history, they cannot

* Article 119.

" be corrected by any felicity of art or genius: and " therefore, if in our Natural History, which is col- " lected, and examined, with so much diligence, so " rigorous, and, as it were, with so religious a seve- " rity, there should sometimes happen any falsity, or " mistake, with regard to particulars; what must be " thought of the common Natural History, which in " comparison of ours, is so negligent and remiss; " or, what of the philosophy, and the sciences, built " upon such quicksands? Let no one, therefore, be " concerned, if our history has its errors."

And, in the Advancement of Learning, when treating of credulity, he says " the matter of manifest " truth is not to be mingled or weakened with matter " of doubtful credit; and yet again, rarities and " reports that seem incredible are not to be sup- " pressed or denied to the memory of men."

From the slightest examination of this work it will appear that, not having such a collection of natural history as he had measured out in his mind, which would have required the purse of a prince and the assistance of a people, Lord Bacon did the best in his power, trying all things but not believing all things, to make such a collection as might render some assistance to future enquirers by pointing out the mode in which a natural history ought to be compiled, without haste in the admission or rejection of received reports. " The rejection," he says, " which I continually use, of experiments, though it appeareth not, is infinite; but yet if an experiment be probable

in the work, and of great use, I receive it, but deliver it as doubtful."

This, perhaps, will be illustrated by some of the articles in the tenth century of this work,* in his enquiry touching the "transmission and influx of "immateriate virtues and the force of imagination," where he thus begins: "The philosophy of Pytha- "goras, which afterwards was, by the school of "Plato and others, watered and nourished. It was, "that the world was one entire perfect living crea- "creature; insomuch as Apollonius of Tyana, a "Pythagorean prophet, affirmed, that the ebbing "and flowing of the sea was the respiration of the "world, drawing in water as breath, and putting it "forth again. They went on, and inferred, that if "the world were a living creature, it had a soul and "spirit; which also they held, calling it spiritus "mundi, the spirit or soul of the world: by which "they did not intend God, for they did admit of a "Deity besides, but only the soul or essential form "of the universe." . . . With these vast and "bottomless follies men have been in part enter- "tained.

"But we, that hold firm to the works of God, "and to the sense, which is God's lamp, lucerna Dei "spiraculum hominis, will inquire with all sobriety "and severity, whether there be to be found in the "footsteps of nature, any such transmission and in-

* See page 487.

" flux of immateriate virtues; and what the force of " imagination is; either upon the body imaginant, or " upon another body; wherein it will be like that " labour of Hercules, in purging the stable of Au- " geas, to separate from superstitious and magical " arts and observations, any thing that is clean and " pure natural; and not to be either contemned or " condemned."

In this spirit, mistaken for credulity, he says,* " the sympathy of individuals, that have been " entire, or have touched, is of all others the most " incredible; yet according unto our faithful man- " ner of examination of nature, we will make some " little mention of it. The taking away of warts, " by rubbing them with somewhat that afterwards " is put to waste and consume, is a common experi- " ment; and I do apprehend it the rather because of " my own experience. I had from my childhood a " wart upon one of my fingers: afterwards, when I " was about sixteen years old, being then at Paris, " there grew upon both my hands a number of " warts, at the least an hundred, in a month's space. " The English ambassador's lady, who was a woman " far from superstition, told me one day, she would " help me away with my warts: whereupon she got " a piece of lard with the skin on, and rubbed the " warts all over with the fat side; and amongst the " rest, that wart which I had had from my child-

* Art. 997, page 530.

"hood: then she nailed the piece of lard, with the "fat towards the sun, upon a post of her chamber "window, which was to the south. The success "was, that within five weeks' space all the warts "went quite away: and that wart which I had so "long endured for company. But at the rest I did "little marvel, because they came in a short time, "and might go away in a short time again: but "the going away of that which had stayed so long "doth yet stick with me."

Again,* "The relations touching the force of "imagination, and the secret instincts of nature, are "so uncertain, as they require a great deal of exami- "nation ere we conclude upon them. I would have "it first thoroughly inquired, whether there be any "secret passages of sympathy between persons of "near blood, as parents, children, brothers, sisters, "nurse-children, husbands, wives. &c. There be "many reports in history, that upon the death of "persons of such nearness, men have had an inward "feeling of it. I myself remember, that being in "Paris, and my father dying in London, two or "three days before my father's death, I had a dream, "which I told to divers English gentlemen, that "my father's house in the country was plastered all "over with black mortar. There is an opinion "abroad, whether idle or no I cannot say, that "loving and kind husbands have a sense of their

* Art. 986, page 525.

" wives breeding children, by some accident in their " own body."*

Passing from these objections to the uses of natural history, they are explained by Lord Bacon in the treatise De Augmentis† and in the Novum Organum.—In the treatise De Augmentis, the subject of Natural History is thus exhibited.

I. *As to the Subject or History.*

1. Of Nature in Course.
    1. Of Celestial Bodies.
    2. Of the Region of the Air.
    3. Of the Earth and Water.
    4. Of the Elements or Genera.
    5. Of the Species.
2. Of Nature wandering or Marvails.
3. Of Arts.

II. *As to its use.*

1. In the Knowledge or *History Narrative.*
2. In being the primitive matter of Philosophy, which he says is defective, and to supply this defect,

* There are in different parts of the Sylva Sylvarum facts evincing Bacon's life of mind, and faculty of generalizing from his earliest infancy. See Art. 946, p. 508, when his mind is at work upon the nature of imagination, most probably before he was 12 years old, when he quitted his father's house for the university, from whence at 16, he went with Sir Amyas Paulet to Paris, and returned after his father's death. See also Art. 151, page 91, when in Trinity College meditating upon the nature of sound. See also Art. 140, page 87, and 148 page 89, and Art. 248, page 127.

† There is considerable difference between the arrangement of this part in the Advancement and the De Augmentis.

to discover the properties of creatures and to impose names, the occupation of Adam in Paradise, his tables of invention are constructed in the Novum Organum with the admonition "That all partitions "of knowledges be accepted rather for lines and "veins, than for sections and separations; and that "the continuance and entireness of knowledge be "preserved."* The sciences being the Pyramids

* There is scarcely a page of his works which does not contain an illustration of this union in all the parts of nature, and the injury to the advancement of knowledge from a supposition of their separation. In the Advancement of Learning he says, "We see Cicero the orator complained of Socrates and his "school, that he was the first that separated philosophy and "rhetoric; whereupon rhetoric became an empty and verbal "art. So we may see that the opinion of Copernicus touching "the rotation of the earth, which astronomy itself cannot "correct, because it is not repugnant to any of the phænomena, "yet natural philosophy may correct. So we see also that the "science of medicine, if it be destituted and forsaken by natu- "ral philosophy, it is not much better than an empirical prac- "tice."

In the treatise De Augmentis, speaking of the mode in which the laws of the heavenly bodies would be discovered, and (if the anecdote respecting Newton and the falling apple is true) were discovered, he thus predicts "whoever shall reject the "feigned divorces of superlunary and sublunary bodies; and "shall intentively observe the appetencies of matter, and the "most universal passions, (which in either globe are exceeding "potent, and transverberate the universal nature of things) he "shall receive clear information concerning celestial matters "from the things seen here with us: and contrariwise from "those motions which are practised in heaven; he shall learn "many observations which now are latent, touching the mo-

supported by history upon experience as their only "and true basis; and so the basis of natural phi- "losophy is natural history; the stage next the

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"tions of bodies here below; not only so far as these inferior "motions are moderated by superior, but in regard they have "a mutual intercourse by passions common to them both."

And to the same effect, he says in another place: "We "must openly profess that our hope of discovering the truth "with regard to the celestial bodies, depends upon the obser- "vation of the common properties, or the passions and appe- "tites of the matter of both states; for, as to the separation "that is supposed betwixt the ætherial and sublunary bodies, it "seems to me no more than a fiction, and a degree of superstiti- "tion mixed with rashness, &c.—Our chiefest hope, and de- "pendence in the consideration of the celestial bodies, is, "therefore, placed in physical reasons, though not such as are "commonly so called; but those laws, which no diversity of "place or region can abolish, break through, disturb, or alter."

And in the Novum Organum, "Suppose, for example, the "inquiry about the nature of spontaneous rotation, attraction, "and many other natures, which are more common and familiar "to us than the celestial bodies themselves. And let no one "expect to determine the question, whether the diurnal motion "belongs to the heavens or the earth, unless he first understand "the nature of spontaneous rotation."

As an instance of this union of nature, and of Bacon's tendency to generalize, see Articles 91, 92, 93, in page 56; and above all, see his suggestions in the Novum Organum, respecting Magical Instances, or great effects produced from apparently small causes. See note A. page 497 of vol. III. of this Work. The correctness of the reasoning I am not now investigating; I am merely stating the fact as an illustration of the union between all nature, and of Bacon's facility is discovering this union.

" basis is physick; the stage next the vertical point " is metaphysick: as for the cone and vertical point " itself (' opus quod operatur Deus à principio " usque ad finem;' the summary law of nature) " we do justly doubt, whether man's enquiry " can attain unto it. But these three be the true " stages of sciences; and are, to men swelled up " with their own knowledge, and a daring insolence " to invade heaven, like the three hills of the giants."

" Ter sunt conati imponere Pelion Ossæ,
" Scilicet atque Ossæ frondosum involvere Olympum."

Of this work there have been many editions: and there is an edition in Latin* published in Holland in 1648† and 1661;‡ and at Frankfort in 1665.§

There are some observations upon the Sylva Sylvarum in Archbishop Tennison's work|| which

* I do not find this in any of the editions of Bacon's Works published in England.

† (12mo.) I have a copy, which is not scarce.

‡ (12mo.) There is a copy in the British Museum.

§ Opera omnia, &c. Folio. Fran. 1665.

|| " The seventh and greatest branch of the Third Part of " the Instauration, is his Sylva Sylvarum, or Natural History; " which containeth many materials for the building of philo- " sophy, as the Organum doth directions for the work. It " is an history not only of nature freely moving in her course, " (as in the production of meteors, plants, minerals;) but also " of nature in constraint, and vexed and tortured by human " art and experiment. And it is not an history of such things " orderly ranged; but thrown into a heap. For his lordship, " that he might not discourage other collectors, did not cast " this book into exact method; for which reason it hath the " less ornament, but not much the less use.

thus conclude, " Whilst I am speaking of this work " of his lordship of Natural History, there comes to

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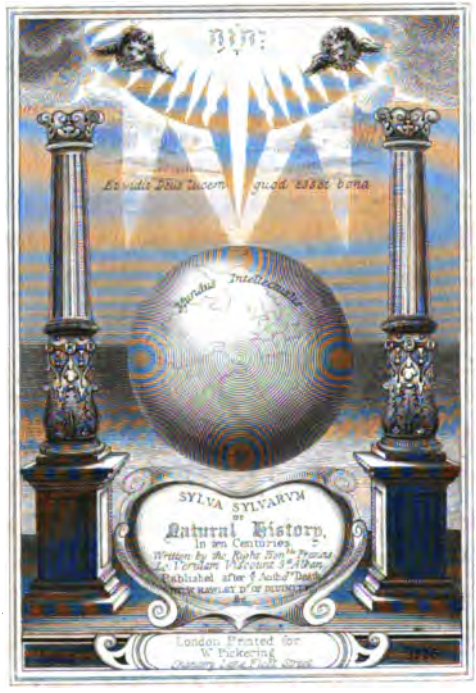
" In this book are contained experiments of light, and " experiments of use (as his lordship was wont to distinguish:) " and amongst them some extraordinary, and others common. " He understood that what was common in one country, might " be a rarity in another: for which reason, Dr. Caius, when in " Italy, thought it worth his pains to make a large and elegant " description of our way of brewing. His lordship also knew " well, that an experiment manifest to the vulgar, was a good " ground for the wise to build further upon. And himself " rendered common ones, extraordinary by admonitions, for " further trials and improvements. Hence his lordship took " occasion to say, that his writing of Sylva Sylvarum, was (to " speak properly) not a Natural History, but a high kind of " natural magic: because it was not only a description of " nature but a breaking of nature into great and strange works.

" This book was written by his lordship in the English " tongue, and translated by an obscure interpreter, into French, " and out of that translation into Latin, by James Gruter, in " such ill manner, that they darkened his lordship's sense, and " debased his expression. James Gruter was sensible of his " miscarriage, being kindly advertised of it by Dr. Rawley: " And he left behind him divers amendments, published by his " brother Isaac Gruter, in a second edition. Yet still so many " errors have escaped, that that work requireth a third hand.

" Monsieur Ælius Deodatus had once engaged an able " person in the translation of this book; one who could have " done his lordship right, and obliged such readers as under- " stood not the English original. He began, and went through " the three first centuries, and then desisted; being desired by " him who set him on work, to take his hand quite off from " that pen, with which he moved so slowly. His translation of " the third century is now in my hands; but that of the two first " I believe is lost." Archbishop Tennison then annexes some specimens of the translation.

" my mind a very memorable relation, reported by
" him who bare a part in it, the Rev. Dr. Rawley.
" One day, his lordship was dictating to that Doctor
" some of the experiments in his Sylva. The same
" day, he had sent a friend to court, to receive for
" him a final answer, touching the effect of a grant
" which had been made him by King James. He had
" hitherto, only hope of it, and hope deferred; and
" he was desirous to know the event of the matter
" and to be freed, one way or other, from the sus-
" pense of his thoughts. His friend returning, told
" him plainly, that he must thenceforth despair of
" that grant, how much soever his fortunes needed
" it. Be it so, said his lordship; and then he dis-
" missed his friend very cheerfully, with thankful
" acknowledgments of his service. His friend being
" gone, he came straightway to Dr. Rawley, and said
" thus to him. Well sir! yon business won't go on;
" let us go on with this, for this is in our power.
" And then he dictated to him afresh, for some
" hours, without the least hesitancy of speech, or
" discernible interruption of thought."


Et vidit Deus lucem quod esset bona
Mundus Intellectualis
SYLVA SYLVARVM
OF
Natural History,
In ten Centuries
Written by the Right Honble Francis
Lo Verulam Viscount St Alban
Published after ye Auth^rs Death
London Printed for
W Pickering

NATURAL HISTORY.

CENTURY I.

Experiments in consort, touching the straining and passing of bodies one through another; which they call Percolation.

Dig a pit upon the sea-shore, somewhat above the high-water mark, and sink it as deep as the low-water mark; and as the tide cometh in, it will fill with water, fresh and potable. This is commonly practised upon the coast of Barbary, where other fresh water is wanting. And Cæsar knew this well when he was besieged in Alexandria: for by digging of pits in the sea-shore, he did frustrate the laborious works of the enemies, which had turned the sea-water upon the wells of Alexandria; and so saved his army being then in desperation. But Cæsar mistook the cause, for he thought that all sea-sands had natural springs of fresh water: but it is plain, that it is the sea-water; because the pit filleth according to the measure of the tide; and the sea-water passing or straining through the sands, leaveth the saltness.

2. I remember to have read, that trial hath been made of salt-water passed through earth, through

ten vessels, one within another; and yet it hath not lost its saltness, as to become potable: but the same man saith, that, by the relation of another, salt-water drained through twenty vessels hath become fresh. This experiment seemeth to cross that other of pits made by the sea-side; and yet but in part, if it be true that twenty repetitions do the effect. But it is worth the note, how poor the imitations of nature are in common course of experiments, except they be led by great judgment, and some good light of axioms. For first, there is no small difference between a passage of water through twenty small vessels, and through such a distance, as between the low-water and high-water mark. Secondly, there is a great difference between earth and sand; for all earth hath in it a kind of nitrous salt, from which sand is more free; and besides, earth doth not strain the water so finely as sand doth. But there is a third point, that I suspect as much or more than the other two; and that is, that in the experiment of transmission of the sea-water into the pits, the water riseth; but in the experiment of transmission of the water through the vessels, it falleth. Now certain it is that the salter part of water, once salted throughout, goeth to the bottom. And therefore no marvel, if the draining of water by descent doth not make it fresh: besides, I do somewhat doubt, that the very dashing of the water, that cometh from the sea, is more proper to strike off the salt part, than where the water slideth of her own motion.

3. It seemeth percolation, or transmission, which

is commonly called straining, is a good kind of separation, not only of thick from thin, and gross from fine, but of more subtile natures; and varieth according to the body through which the transmission is made: as if through a woollen bag, the liquor leaveth the fatness; if through sand, the saltness, &c. They speak of severing wine from water, passing it through ivy wood, or through other the like porous body; but "non constat."

4. The gum of trees, which we see to be commonly shining and clear, is but a fine passage or straining of the juice of the tree through the wood and bark. And in like manner, Cornish diamonds, and rock rubies, which are yet more resplendent than gums, are the fine exudations of stone.

5. Aristotle giveth the cause, vainly, why the feathers of birds are of more lively colours than the hairs of beasts; for no beast hath any fine azure, or carnation, or green hair. He saith, it is because birds are more in the beams of the sun than beasts; but that is manifestly untrue; for cattle are more in the sun than birds, that live commonly in the woods, or in some covert. The true cause is, that the excrementitious moisture of living creatures, which maketh as well the feathers in birds, as the hair in beasts, passeth in birds through a finer and more delicate strainer than it doth in beasts: for feathers pass through quills; and hair through skin.

6. The clarifying of liquors by adhesion, is an inward percolation; and is effected, when some cleaving body is mixed and agitated with the liquors; whereby the grosser part of the liquor sticks to that

cleaving body; and so the finer parts are freed from the grosser. So the apothecaries clarify their syrups by whites of eggs, beaten with the juices which they would clarify; which whites of eggs gather all the dregs and grosser parts of the juice to them; and after the syrup being set on the fire, the whites of eggs themselves harden, and are taken forth. So hippocras is clarified by mixing with milk, and stirring it about, and then passing it through a woollen bag, which they call Hippocrates's Sleeve, and the cleaving nature of the milk draweth the powder of the spices, and grosser parts of the liquor to it; and in the passage they stick upon the woollen bag.

7. The clarifying of water is an experiment tending to health; besides the pleasure of the eye, when water is crystalline. It is effected by casting in and placing pebbles at the head of a current, that the water may strain through them.

8. It may be, percolation doth not only cause clearness and splendour, but sweetness of savour; for that also followeth as well as clearness, when the finer parts are severed from the grosser. So it is found, that the sweats of men, that have much heat, and exercise much, and have clean bodies, and fine skins, do smell sweet; as was said of Alexander; and we see commonly that gums have sweet odours.

Experiments in consort, touching motion of bodies upon their pressure.

9. Take a glass, and put water into it, and wet your finger, and draw it round about the lip of the

glass, pressing it somewhat hard; and after you have drawn it some few times about, it will make the water frisk and sprinkle up in a fine dew. This instance doth excellently demonstrate the force of compression in a solid body: for whensoever a solid body, as wood, stone, metal, &c. is pressed, there is an inward tumult in the parts thereof seeking to deliver themselves from the compression: and this is the cause of all violent motion. Wherein it is strange in the highest degree, that this motion hath never been observed, nor inquired; it being of all motions the most common, and the chief root of all mechanical operations. This motion worketh in round at first, by way of proof and search which way to deliver itself: and then worketh in progress, where it findeth the deliverance easiest. In liquors this motion is visible; for all liquors strucken make round circles, and withal dash; but in solids, which break not, it is so subtile, as it is invisible; but nevertheless bewrayeth itself by many effects; as in this instance whereof we speak. For the pressure of the finger, furthered by the wetting, because it sticketh so much the better unto the lip of the glass, after some continuance, putteth all the small parts of the glass into work, that they strike the water sharply; from which percussion that sprinkling cometh.

10. If you strike or pierce a solid body that is brittle, as glass, or sugar, it breaketh not only where the immediate force is; but breaketh all about into

shivers and fitters; the motion, upon the pressure, searching all ways, and breaking where it findeth the body weakest.

11. The powder in shot, being dilated into such a flame as endureth not compression, moveth likewise in round, the flame being in the nature of a liquid body, sometimes recoiling, sometimes breaking the piece, but generally discharging the bullet, because there it findeth easiest deliverance.

12. This motion upon pressure, and the reciprocal thereof, which is motion upon tensure, we use to call, by one common name, motion of liberty; which is, when any body, being forced to a preternatural extent or dimension, delivereth and restoreth itself to the natural: as when a blown bladder pressed, riseth again; or when leather or cloth tentured, spring back. These two motions, of which there be infinite instances, we shall handle in due place.

13. This motion upon pressure is excellently also demonstrated in sounds; as when one chimeth upon a bell, it soundeth; but as soon as he layeth his hand upon it, the sound ceaseth: and so the sound of a virginal string, as soon as the quill of the jack falleth from it, stoppeth. For these sounds are produced by the subtile percussion of the minute parts of the bell, or string, upon the air; all one, as the water is caused to leap by the subtile percussion of the minute parts of the glass, upon the water, whereof we spake a little before in the ninth experiment. For

you must not take it to be the local shaking of the bell, or string, that doth it: as we shall fully declare when we come hereafter to handle sounds.

Experiments in consort, touching separations of bodies by weight.

14. Take a glass with a belly and a long neb; fill the belly, in part, with water: take also another glass, whereinto put claret wine and water mingled; reverse the first glass, with the belly upwards stopping the neb with your finger; then dip the mouth of it within the second glass, and remove your finger: continue it in that posture for a time; and it will unmingle the wine from the water: the wine ascending and settling in the top of the upper glass; and the water descending and settling in the bottom of the lower glass. The passage is apparent to the eye; for you shall see the wine, as it were, in a small vein, rising through the water. For handsomeness sake, because the working requireth some small time, it were good you hang the upper glass upon a nail. But as soon as there is gathered so much pure and unmixed water in the bottom of the lower glass, as that the mouth of the upper glass dippeth into it, the motion ceaseth.

15. Let the upper glass be wine, and the lower water; there followeth no motion at all. Let the upper glass be water pure, the lower water coloured, or contrariwise, there followeth no motion at all. But it hath been tried, that though the mixture of wine and water, in the lower glass, be three parts

water and but one wine, yet it doth not dead the motion. This separation of water and wine appeareth to be made by weight; for it must be of bodies of unequal weight, or else it worketh not; and the heavier body must ever be in the upper glass. But then note withal, that the water being made pensile, and there being a great weight of water in the belly of the glass, sustained by a small pillar of water in the neck of the glass, it is that which setteth the motion on work: for water and wine in one glass, with long standing, will hardly sever.

16. This experiment would be extended from mixtures of several liquors, to simple bodies which consist of several similar parts: try it therefore with brine or salt-water, and fresh-water; placing the salt-water, which is the heavier, in the upper glass; and see whether the fresh will come above. Try it also with water thick sugared, and pure water; and see whether the water, which cometh above, will lose its sweetness: for which purpose it were good there were a little cock made in the belly of the upper glass.

Experiments in consort, touching judicious and accurate infusions, both in liquors and air.

17. In bodies containing fine spirits, which do easily dissipate, when you make infusions, the rule is, a short stay of the body in the liquor, receiveth the spirit; and a longer stay confoundeth it; because it draweth forth the earthy part withal, which em-

baseth the finer. And therefore it is an error in physicians, to rest simply upon the length of stay for increasing the virtue. But if you will have the infusion strong, in those kinds of bodies which have fine spirits, your way is not to give longer time, but to repeat the infusion of the body oftener. Take violets, and infuse a good pugil of them in a quart of vinegar; let them stay three quarters of an hour, and take them forth, and refresh the infusion with like quantity of new violets, seven times; and it will make a vinegar so fresh of the flower, as if, a twelvemonth after, it be brought you in a saucer, you shall smell it before it come at you. Note, that it smelleth more perfectly of the flower a good while after than at first.

18. This rule, which we have given, is of singular use for the preparations of medicines, and other infusions. As for example: the leaf of burrage hath an excellent spirit to repress the fuliginous vapour of dusky melancholy, and so to cure madness: but nevertheless, if the leaf be infused long it yieldeth forth but a raw substance, of no virtue: therefore I suppose, that if in the must of wine, or wort of beer, while it worketh, before it be tunned, the burrage stay a small time, and be often changed with fresh; it will make a sovereign drink for melancholy passions. And the like I conceive of orange flowers.

19. Rhubarb hath manifestly in it parts of contrary operations: parts that purge; and parts that bind the body: and the first lie looser, and the latter

lie deeper: so that if you infuse rhubarb for an hour, and crush it well, it will purge better, and bind the body less after the purging than if it had stood twenty-four hours; this is tried: but I conceive likewise, that by repeating the infusion of rhubarb several times, as was said of violets, letting each stay in but a small time, you may make it as strong a purging medicine as scammony. And it is not a small thing won in physic, if you can make rhubarb, and other medicines that are benedict, as strong purgers as those that are not without some malignity.

20. Purging medicines, for the most part, have their purgative virtue in a fine spirit; as appeareth by that they endure not boiling without much loss of virtue. And therefore it is of good use in physic, if you can retain the purging virtue, and take away the unpleasant taste of the purger; which it is like you may do, by this course of infusing oft, with little stay, for it is probable that the horrible and odious taste is in the grosser part.

21. Generally, the working by infusions is gross and blind, except you first try the issuing of the several parts of the body, which of them issue more speedily, and which more slowly; and so by apportioning the time, can take and leave that quality which you desire. This to know there be two ways; the one to try what long stay, and what short stay worketh, as hath been said; the other to try in order the succeeding infusions of one and the same body, successively, in several liquors. As for ex-

ample; take orange pills, or rosemary, or cinnamon, or what you will; and let them infuse half an hour in water; then take them out, and infuse them again in other water; and so the third time: and then taste and consider the first water, the second, and the third; and you will find them differing, not only in strength and weakness, but otherwise in taste or odour; for it may be the first water will have more of the scent, as more fragrant; and the second more of the taste, as more bitter or biting, &c.

22. Infusions in air, for so we may well call odours, have the same diversities with infusions in water; in that the several odours, which are in one flower, or other body, issue at several times; some earlier, some later: so we find that violets, woodbines, strawberries, yield a pleasing scent, that cometh forth first; but soon after an ill scent quite differing from the former. Which is caused, not so much by mellowing, as by the late issuing of the grosser spirit.

23. As we may desire to extract the finest spirits in some cases; so we may desire also to discharge them, as hurtful, in some other. So wine burnt, by reason of the evaporating of the finer spirit, inflameth less, and is best in agues: opium loseth some of its poisonous quality, if it be vapoured out, mingled with spirit of wine, or the like: sena loseth somewhat of its windiness by decocting; and generally, subtile or windy spirits are taken off by incension, or evaporation. And even in infusions in things that are of too high a spirit, you were better pour

off the first infusion, after a small time, and use the latter.

Experiment solitary touching the appetite of continuation in liquids.

24. Bubbles are in the form of an hemisphere; air within, and a little skin of water without: and it seemeth somewhat strange, that the air should rise so swiftly while it is in the water; and when it cometh to the top, should be stayed by so weak a cover as that of the bubble is. But as for the swift ascent of the air, while it is under the water, that is a motion of percussion from the water; which itself descending driveth up the air; and no motion of levity in the air. And this Democritus called "motus plagæ." In this common experiment, the cause of the inclosure of the bubble is, for that the appetite to resist separation, or discontinuance, which in solid bodies is strong, is also in liquors, though fainter and weaker; as we see in this of the bubble: we see it also in little glasses of spittle that children make of rushes; and in castles of bubbles, which they make by blowing into water, having obtained a little degree of tenacity by mixture of soap: we see it also in the stillicides of water, which if there be water enough to follow, will draw themselves into a small thread, because they will not discontinue; but if there be no remedy, then they cast themselves into round drops; which is the figure that saveth the body most from discontinuance: the same reason is of the roundness of the bubble, as

well for the skin of water, as for the air within: for the air likewise avoideth discontinuance; and therefore casteth itself into a round figure. And for the stop and arrest of the air a little while, it sheweth that the air of itself hath little or no appetite of ascending.

Experiment solitary touching the making of artificial springs.

25. The rejection, which I continually use, of experiments, though it appeareth not, is infinite; but yet if an experiment be probable in the work, and of great use, I receive it, but deliver it as doubtful. It was reported by a sober man, that an artificial spring may be made thus: Find out a hanging ground, where there is a good quick fall of rain-water. Lay a half-trough of stone, of a good length, three or four foot deep within the same ground; with one end upon the high ground, the other upon the low. Cover the trough with brakes a good thickness, and cast sand upon the top of the brakes: you shall see, saith he, that after some showers are past, the lower end of the trough will run like a spring of water: which is no marvel, if it hold while the rain water lasteth; but he said it would continue long time after the rain is past: as if the water did multiply itself upon the air, by the help of the coldness and condensation of the earth, and the consort of the first water.

Experiment solitary touching the venomous quality of man's flesh.

26. The French, which put off the name of the

French disease unto the name of the disease of Naples, do report, that at the siege of Naples, there were certain wicked merchants that barrelled up man's flesh, of some that had been lately slain in Barbary, and sold it for tunney; and that upon that foul and high nourishment was the original of that disease. Which may well be, for that it is certain that the cannibals in the West Indies eat man's flesh: and the West Indies were full of the pox when they were first discovered: and at this day the mortalest poisons, practised by the West Indians, have some mixture of the blood, or fat, or flesh of man: and divers witches and sorceresses, as well amongst the heathen as amongst the christians, have fed upon man's flesh, to aid, as it seemeth, their imagination, with high and foul vapours.

Experiment solitary touching the version and transmutation of air into water.

27. It seemeth that there be these ways, in likelihood, of version or vapours of air, into water and moisture. The first is cold; which doth manifestly condense; as we see in the contracting of the air in the weather-glass; whereby it is a degree nearer to water. We see it also in the generation of springs, which the ancients thought, very probably, to be made by the version of air into water, holpen by the rest, which the air hath in those parts; whereby it cannot dissipate. And by the coldness of rocks; for there springs are chiefly generated. We see it also in the effects of the cold of the middle region, as

they call it, of the air; which produceth dews and rains. And the experiment of turning water into ice, by snow, nitre, and salt, whereof we shall speak hereafter, would be transferred to the turning of air into water. The second way is by compression; as in stillatories, where the vapour is turned back upon itself, by the encounter of the sides of the stillatory; and in the dew upon the covers of boiling pots; and in the dew towards rain, upon marble and wainscot. But this is like to do no great effect; except it be upon vapours, and gross air, that are already very near in degree to water. The third is that, which may be searched into, but doth not yet appear; which is, by mingling of moist vapours with air; and trying if they will not bring a return of more water, than the water was as first: for if so, that increase is a version of the air: therefore put water into the bottom of a stillatory, with the neb stopped; weigh the water first; hang in the middle of the stillatory a large spunge; and see what quantity of water you can crush out of it; and what it is more, or less, compared with the water spent: for you must understand, that if any version can be wrought, it will be easiliest done in small pores: and that is the reason why we prescribe a spunge. The fourth way is probable also, though not appearing; which is, by receiving the air into the small pores of bodies: for, as hath been said, every thing in small quantity is more easy for version; and tangible bodies have no pleasure in the consort of air, but endeavour to subact

it into a more dense body; but in intire bodies it is checked; because if the air should condense, there is nothing to succeed: therefore it must be in loose bodies, as sand, and powder; which we see, if they lie close, of themselves gather moisture.

Experiment solitary touching helps towards the beauty and good features of persons.

28. It is reported by some of the ancients; that whelps, or other creatures, if they be put young into such a cage or box, as they cannot rise to their stature, but may increase in breadth or length, will grow accordingly as they can get room; which if it be true and feasible, and that the young creature so pressed and straitened, doth not thereupon die, it is a means to produce dwarf creatures, and in a very strange figure. This is certain, and noted long since, that the pressure or forming of parts of creatures, when they are very young, doth alter the shape not a little: as the stroking of the heads of infants, between the hands, was noted of old, to make "Macrocephali;" which shape of the head, at that time, was esteemed. And the raising gently of the bridge of the nose, doth prevent the deformity of a saddle nose. Which observation well weighed, may teach a means to make the persons of men and women, in many kinds, more comely and better featured than otherwise they would be; by the forming and shaping of them in their infancy: as by stroking up the calves of the legs, to keep them from falling down too low; and by stroking up the

forehead, to keep them from being low-foreheaded. And it is a common practice to swathe infants, that they may grow more straight and better shaped: and we see young women, by wearing strait bodice, keep themselves from being gross and corpulent.

Experiment solitary touching the condensing of air in such sort as it may put on weight, and yield nourishment.

29. Onions, as they hang, will many of them shoot forth; and so will penny-royal; and so will an herb called orpin; with which they use in the country to trim their houses, binding it to a lath or stick, and setting it against a wall. We see it likewise, more especially, in the greater semper-vive, which will put out branches, two or three years: but it is true, that commonly they wrap the root in a cloth besmeared with oil, and renew it once in half a year. The like is reported by some of the ancients, of the stalks of lilies. The cause is; for that these plants have a strong, dense, and succulent moisture, which is not apt to exhale; and so is able, from the old store, without drawing help from the earth, to suffice the sprouting of the plant: and this sprouting is chiefly in the late spring or early summer; which are the times of putting forth. We see also, that stumps of trees lying out of the ground, will put forth sprouts for a time. But it is a noble trial, and of very great consequence, to try whether these things, in the sprouting, do increase weight; which must be tried, by

weighing them before they be hanged up; and afterwards again, when they are sprouted. For if they increase not in weight, then it is no more but this; that what they send forth in the sprout, they lose in some other part: but if they gather weight, then it is "magnale naturæ;" for it sheweth that air may be made so to be condensed, as to be converted into a dense body; whereas the race and period of all things, here above the earth, is to extenuate and turn things to be more pneumatical and rare; and not to be retrograde, from pneumatical to that which is dense. It sheweth also, that air can nourish; which is another great matter of consequence. Note, that to try this, the experiment of the sempervive must be made without oiling the cloth; for else, it may be, the plant receiveth nourishment from the oil.

Experiment solitary touching the commixture of flame and air, and the great force thereof.

30. Flame and air do not mingle, except it be in an instant; or in the vital spirits of vegetables and living creatures. In gunpowder, the force of it hath been ascribed to rarefaction of the earthy substance into flame; and thus far it is true: and then, forsooth, it is become another element; the form whereof occupieth more place; and so of necessity, followeth a dilatation: and therefore, lest two bodies should be in one place, there must needs also follow an expulsion of the pellet; or blowing up of the mine. But these are crude and ignorant

speculations. For flame, if there were nothing else, except it were in very great quantity, will be suffocate with any hard body, such as a pellet is; or the barrel of a gun; so as the flame would not expel the hard body; but the hard body would kill the flame, and not suffer it to kindle or spread. But the cause of this so potent a motion, is the nitre, which we call otherwise saltpetre, which having in it a notable crude and windy spirit, first by the heat of the fire suddenly dilateth itself; and we know that simple air, being preternaturally attenuated by heat, will make itself room, and break and blow up that which resisteth it; and secondly, when the nitre hath dilated itself, it bloweth abroad the flame, as an inward bellows. And therefore we see that brimstone, pitch, camphire, wild-fire, and divers other inflammable matters, though they burn cruelly, and are hard to quench, yet they make no such fiery wind as gunpowder doth: and on the other side, we see that quick-silver, which is a most crude and watery body, heated, and pent in, hath the like force with gunpowder. As for living creatures, it is certain, their vital spirits are a substance compounded of an airy and flamy matter; and though air and flame being free, will not well mingle; yet bound in by a body that hath some fixing, they will. For that you may best see in those two bodies, which their aliments, water and oil; for they likewise will not well mingle of themselves; but in the bodies of plants, and living creatures, they will. It is no marvel therefore, that a

small quantity of spirits, in the cells of the brain and canals of the sinews, are able to move the whole body, which is of so great mass, both with so great force, as in wrestling, leaping; and with so great swiftness, as in playing division upon the lute. Such is the force of these two natures, air and flame, when they incorporate.

Experiment solitary touching the secret nature of flame.

31. Take a small wax candle, and put it in a socket of brass or iron; then set it upright in a porringer full of spirit of wine heated: then set both the candle and spirit of wine on fire, and you shall see the flame of the candle open itself, and become four or five times bigger than otherwise it would have been; and appear in figure globular, and not in pyramis. You shall see also, that the inward flame of the candle keepeth colour, and doth not wax any whit blue towards the colour of the outward flame of the spirit of wine. This is a noble instance; wherein two things are most remarkable: the one, that one flame within another quencheth not; but is a fixed body, and continueth as air or water do. And therefore flame would still ascend upwards in one greatness, if it were not quenched on the sides: and the greater the flame is at the bottom, the higher is the rise. The other, that flame doth not mingle with flame, as air doth with air, or water with water, but only remaineth contiguous; as it cometh to pass betwixt consisting bodies. It appeareth also, that the form of a pyramis in flame,

which we usually see, is merely by accident, and that the air about, by quenching the sides of the flame, crusheth it, and extenuateth it into that form; for of itself it would be round; and therefore smoke is in the figure of a pyramis reversed; for the air quencheth the flame, and receiveth the smoke. Note also, that the flame of the candle, within the flame of the spirit of wine, is troubled; and doth not only open and move upwards, but moveth waving, and to and fro; as if flame of its own nature, if it were not quenched, would roll and turn, as well as move upwards. By all which it should seem, that the celestial bodies, most of them, are true fires or flames, as the Stoics held; more fine, perhaps, and rarified than our flame is. For they are all globular and determinate; they have rotation; and they have the colour and splendour of flame: so that flame above is durable, and consistent, and in its natural place; but with us it is a stranger, and momentany, and impure: like Vulcan that halted with his fall.

Experiment solitary touching the different force of flame in the midst and on the sides.

32. Take an arrow, and hold it in flame for the space of ten pulses, and when it cometh forth, you shall find those parts of the arrow which were on the outsides of the flame more burned, blacked, and turned almst into a coal, whereas that in the midst of the flame will be as if the fire had scarce touched it. This is an instance of great consequence for the discovery of the nature of flame; and sheweth mani-

festly, that flame burneth more violently towards the sides than in the midst: and which is more, that heat or fire is not violent or furious, but where it is checked and pent. And therefore the Peripateties, howsoever their opinion of an element of fire above the air is justly exploded, in that point they acquit themselves well: for being opposed, that if there were a sphere of fire, that encompassed the earth so near hand, it were impossible but all things should be burnt up; they answer, that the pure elemental fire, in its own place, and not irritated, is but of a moderate heat.

Experiment solitary touching the decrease of the natural motion of gravity, in great distance from the earth; or within some depth of the earth.

33. It is affirmed constantly by many, as an usual experiment; that a lump of ore, in the bottom of a mine, will be tumbled and stirred by two men's strength; which if you bring it to the top of the earth, will ask six men's strength at the least to stir it. It is a noble instance, and is fit to be tried to the full; for it is very probable, that the motion of gravity, worketh weakly, both far from the earth, and also within the earth: the former, because the appetite of union of dense bodies with the earth, in respect of the distance, is more dull: the latter, because the body hath in part attained its nature when it is some depth in the earth. For as for the moving to a point or place, which was the opinion of the ancients, it is a mere vanity.

Experiment solitary touching the contraction of bodies in bulk, by the mixture of the more liquid body with the more solid.

34. It is strange how the ancients took up experiments upon credit, and yet did build great matters upon them. The observation of some of the best of them, delivered confidently, is, that a vessel filled with ashes will receive the like quantity of water, that it would have done if it had been empty. But this is utterly untrue, for the water will not go in by a fifth part. And I suppose, that that fifth part is the difference of the lying close, or open, of the ashes; as we see that ashes alone, if they be hard pressed, will lie in less room: and so the ashes with air between, lie looser; and with water closer. For I have not yet found certainly, that the water itself, by mixture of ashes or dust, will shrink or draw into less room.

Experiment solitary touching the making vines more fruitful.

35. It is reported of credit, that if you lay good store of kernels of grapes about the root of a vine, it will make the vine come earlier and prosper better. It may be tried with other kernels laid about the root of a plant of the same kind; as figs, kernels of apples, &c. The cause may be, for that the kernels draw out of the earth juice fit to nourish the tree, as those that would be trees of themselves, though there were no root; but the root being of greater

strength robbeth and devoureth the nourishment, when they have drawn it: as great fishes devour little.

Experiments in consort touching purging medicines.

36. The operation of purging medicines, and the causes thereof, have been thought to be a great secret; and so according to the slothful manner of men, it is referred to a hidden propriety, a specifical virtue, and a fourth quality, and the like shifts of ignorance. The causes of purging are divers: all plain and perspicuous, and thoroughly maintained by experience. The first is, that whatsoever cannot be overcome and digested by the stomach, is by the stomach either put up by vomit, or put down to the guts; and by that motion of expulsion in the stomach and guts, other parts of the body, as the orifices of the veins, and the like, are moved to expel by consent. For nothing is more frequent than motion of consent in the body of man. This surcharge of the stomach is caused either by the quality of the medicine, or by the quantity. The qualities are three: extreme bitter, as in aloes, coloquintida, &c. loathsome and of horrible taste, as in agaric, black hellebore, &c. and of secret malignity, and disagreement towards man's body, many times not appearing much in the taste, as in scammony, mechoachan, antimony, &c. And note well, that if there be any medicine that purgeth, and hath neither of the first two manifest qualities, it is to be held suspected as a kind of poison; for that it worketh either by cor-

rosion, or by a secret malignity, and enmity to nature; and therefore such medicines are warily to be prepared and used. The quantity of that which is taken doth also cause purging; as we see in a great quantity of new milk from the cow; yea and a great quantity of meat; for surfeits many times turn to purges, both upwards and downwards. Therefore we see generally, that the working of purging medicines cometh two or three hours after the medicines taken: for that the stomach first maketh a proof whether it can concoct them. And the like happeneth after surfeits, or milk in too great quantity.

37. A second cause is mordication of the orifices of the parts; especially of the mesentery veins; as it is seen, that salt, or any such thing that is sharp and biting, put in the fundament, doth provoke the part to expel; and mustard provoketh sneezing: and any sharp thing to the eyes provoketh tears. And therefore we see that almost all purgers have a kind of twitching and vellication, besides the griping which cometh of wind. And if this mordication be in an over-high degree, it is little better than the corrosion of poison; and it cometh to pass sometimes in antimony, especially if it be given to bodies not replete with humours; for where humours abound, the humours save the parts.

38. The third cause is attraction: for I do not deny, but that purging medicines have in them a direct force of attraction; as drawing plaisters have in surgery: and we see sage or betony bruised, sneez-

ing powder, and other powders, or liquors, which the physicians call "errhines," put into the nose, draw phlegm and water from the head; and so it is in apophlegmatisms and gargarisms, that draw the rheum down by the palate. And by this virtue, no doubt, some purgers draw more one humour, and some another, according to the opinion received: as rhubarb draweth choler; sena melancholy; agaric phlegm, &c. but yet, more or less, they draw promiscuously. And note also, that besides sympathy between the purger and the humour, there is also another cause, why some medicines draw some humour more than another. And it is, for that some medicines work quicker than others: and they that draw quick, draw only the lighter and more fluid humours; and they that draw slow, work upon the more tough and viscous humours. And therefore men must beware how they take rhubarb, and the like, alone familiarly; for it taketh only the lightest part of the humour away, and leaveth the mass of humours more obstinate. And the like may be said of wormwood, which is so much magnified.

39. The fourth cause is flatuosity; for wind stirred moveth to expel: and we find that in effect all purgers have in them a raw spirit or wind; which is the principal cause of tortion in the stomach and belly. And therefore purgers lose, most of them, the virtue by decoction upon the fire; and for that cause are given chiefly in infusion, juice, or powder.

40. The fifth cause is compression or crushing; as when water is crushed out of a spunge: so we see

that taking cold moveth looseness by contraction of the skin and outward parts; and so doth cold likewise cause rheums, and defluxions from the head; and some astringent plaisters crush out purulent matter. This kind of operation is not found in many medicines; myrobolanes have it; and it may be the barks of peaches; for this virtue requireth an astriction; but such an astriction as is not grateful to the body; for a pleasing astriction doth rather bind in the humours than expel them: and therefore, such astriction is found in things of an harsh taste.

41. The sixth cause is lubrefaction and relaxation. As we see in medicines emollient; such as are milk, honey, mallows, lettice, mercurial, pellitory of the wall, and others. There is also a secret virtue of relaxation in cold: for the heat of the body bindeth the parts and humours together, which cold relaxeth: as it is seen in urine, blood, pottage, or the like; which, if they be cold, break and dissolve. And by this kind of relaxation, fear looseneth the belly: because the heat retiring inwards towards the heart, the guts, and other parts are relaxed; in the same manner as fear also causeth trembling in the sinews. And of this kind of purgers are some medicines made of mercury.

42. The seventh cause is abstersion; which is plainly a scouring off, or incision of the more viscous humours, and making the humours more fluid; and cutting between them and the part; as is found in nitrous water, which scoureth linen cloth speedily from the foulness. But this incision must be by a

sharpness, without astriction: which we find in salt, wormwood, oxymel, and the like.

43. There be medicines that move stools, and not urine; some other, urine and not stools. Those that purge by stool, are such as enter not at all, or little, into the mesentery veins; but either at the first are not digestible by the stomach, and therefore move immediately downwards to the guts; or else are afterwards rejected by the mesentery veins, and so turn likewise downwards to the guts; and of these two kinds are most purgers. But those that move urine, are such as are well digested of the stomach, and well received also of the mesentery veins; so they come as far as the liver, which sendeth urine to the bladder, as the whey of blood: and those medicines being opening and piercing, do fortify the operation of the liver, in sending down the wheyey part of the blood to the reins. For medicines urinative do not work by rejection and indigestion, as solutive do.

44. There be divers medicines, which in greater quantity move stool, and in smaller urine: and so contrariwise, some that in greater quantity move urine, and in smaller stool. Of the former sort is rhubarb, and some others. The cause is, for that rhubarb is a medicine which the stomach in a small quantity doth digest and overcome, being not flatuous nor loathsome, and so sendeth it to the mesentery veins; and so being opening, it helpeth down urine: but in a greater quantity, the stomach cannot overcome it, and so it goeth to the guts. Pepper by

some of the ancients is noted to be of the second sort; which being in small quantity, moveth wind in the stomach and guts, and so expelleth by stool; but being in greater quantity, dissipateth the wind; and itself getteth to the mesentery veins, and so to the liver and reins; where, by heating and opening, it sendeth down urine more plentifully.

Experiments in consort touching meats and drinks that are most nourishing.

45. We have spoken of evacuating of the body; we will now speak something of the filling of it by restoratives in consumptions and emaciating diseases. In vegetables, there is one part that is more nourishing than another; as grains and roots nourish more than the leaves; insomuch as the order of the Foliatanes was put down by the pope, as finding leaves unable to nourish man's body. Whether there be, that difference in the flesh of living creatures, is not well inquired: as whether livers, and other entrails be not more nourishing than the outward flesh. We find that amongst the Romans, a goose's liver was a great delicacy; insomuch as they had artificial means to make it fair and great; but whether it were more nourishing appeareth not. It is certain, that marrow is more nourishing than fat. And I conceive that some decoction of bones and sinews, stamped and well strained, would be a very nourishing broth: we find also that Scotch skinck, which is a pottage of strong nourishment, is made with the knees and sinews of beef, but long boiled: jelly also, which

they use for a restorative, is chiefly made of knuckles of veal. The pulp that is within the crawfish or crab, which they spice and butter, is more nourishing than the flesh of the crab or crawfish. The yolks of eggs are clearly more nourishing than the whites. So that it should seem, that the parts of living creatures that lie more inwards, nourish more than the outward flesh; except it be the brain: which the spirits prey too much upon, to leave it any great virtue of nourishing. It seemeth for the nourishing of aged men, or men in consumptions, some such thing should be devised, as should be half chylus, before it be put into the stomach.

46. Take two large capons; parboil them upon a soft fire, by the space of an hour or more, till in effect, all the blood is gone. Add in the decoction the pill of a sweet lemon, or a good part of the pill of a citron, and a little mace. Cut off the shanks, and throw them away. Then with a good strong chopping-knife mince the two capons, bones and all, as small as ordinary minced meat; put them into a large neat boulter; then take a kilderkin, sweet and well seasoned, of four gallons of beer, of 8s. strength, new as it cometh from the tunning: make in the kilderkin a great bung-hole of purpose: then thrust into it the boulter, in which the capons are, drawn out in length; let it steep in it three days and three nights, the bung-hole open to work, then close the bung-hole, and so let it continue a day and a half; then draw it into bottles, and you may drink it well after three days bottling; and it will last six weeks: approved. It drink-

eth fresh, flowereth and mantleth exceedingly; it drinketh not newish at all; it is an excellent drink for a consumption, to be drunk either alone, or carded with some other beer. It quencheth thirst, and hath no whit of windiness. Note, that it is not possible, that meat and bread, either in broths, or taken with drink, as is used, should get forth into the veins and outward parts, so finely and easily, as when it is thus incorporate, and made almost a chylus aforehand.

47. Trial would be made of the like brew with potatoe roots, or burr roots, or the pith of artichokes, which are nourishing meats: it may be tried also with other flesh; as pheasant, partridge, young pork, pig, venison, especially of young deer, &c.

48. A mortress made with the brawn of capons, stamped and strained, and mingled, after it is made, with like quantity, at the least, of almond butter, is an excellent meat to nourish those that are weak; better than blanckmanger, or jelly: and so is the cullice of cocks, boiled thick with the like mixture of almond butter; for the mortress or cullice, of itself, is more savoury and strong, and not so fit for nourishing of weak bodies; but the almonds, that are not of so high a taste as flesh, do excellently qualify it.

49. Indian maiz hath, of certain, an excellent spirit of nourishment; but it must be throughly boiled, and made into a maiz-cream like a barley-cream. I judge the same of rice, made into a cream; for rice is in Turkey, and other countries of the east,

most fed upon; but it must be thoroughly boiled in respect of the hardness of it, and also because otherwise it bindeth the body too much.

50. Pistachoes, so they be good, and not musty, joined with almonds in almond milk; or made into a milk of themselves, like unto almond milk, but more green, are an excellent nourisher: but you shall do well, to add a little ginger, scraped, because they are not without some subtile windiness.

51. Milk warm from the cow, is found to be a great nourisher, and a good remedy in consumptions: but then you must put into it, when you milk the cow, two little bags; the one of powder of mint, the other of powder of red roses; for they keep the milk somewhat from turning or curdling in the stomach; and put in sugar also, for the same cause, and partly for the taste's sake; but you must drink a good draught, that it may stay less time in the stomach, lest it curdle: and let the cup into which you milk the cow, be set in a greater cup of hot water, that you may take it warm. And cow milk thus prepared, I judge to be better for a consumption, than ass milk, which it is true, turneth not so easily, but it is a little harsh; marry it is more proper for sharpness of urine, and exculceration of the bladder, and all manner of lenifying. Woman's milk likewise is prescribed, when all fail; but I commend it not, as being a little too near the juice of man's body, to be a good nourisher; except it be in infants, to whom it is natural.

52. Oil of sweet almonds, newly drawn, with

sugar, and a little spice, spread upon bread toasted, is an excellent nourisher: but then to keep the oil from frying in the stomach, you must drink a good draught of mild beer after it; and to keep it from relaxing the stomach too much, you must put in a little powder of cinnamon.

53. The yolks of eggs are of themselves so well prepared by nature for nourishment, as, so they be poached, or reare boiled, they need no other preparation or mixture; yet they may be taken also raw, when they are new laid, with Malmsey, or sweet wine: you shall do well to put in some few slices of eryngium roots, and a little ambergrice; for by this means, besides the immediate faculty of nourishment, such drink will strengthen the back, so that it will not draw down the urine too fast; for too much urine doth always hinder nourishment.

54. Mincing of meat, as in pies, and buttered minced meat, saveth the grinding of the teeth; and therefore, no doubt, it is more nourishing, especially in age, or to them that have weak teeth; but the butter is not so proper for weak bodies; and therefore it were good to moisten it with a little claret wine, pill of lemon or orange, cut small, sugar, and a very little cinnamon or nutmeg. As for chuets, which are likewise minced meat, instead of butter and fat, it were good to moisten them, partly with cream, or almond, or pistacho milk: or barley, or maiz-cream; adding a little coriander seed and caraway seed, and a very little saffron. The more full

handling of alimentation we reserve to the due place.

We have hitherto handled the particulars which yield best, and easiest, and plentifullest nourishment; and now we will speak of the best means of conveying and converting the nourishment.

55. The first means is to procure that the nourishment may not be robbed and drawn away; wherein that which we have already said is very material; to provide that the reins draw not too strongly an over great part of the blood into urine. To this add that precept of Aristotle, that wine be forborn in all consumptions; for that the spirits of the wine do prey upon the roscid juice of the body, and inter-common with the spirits of the body, and so deceive and rob them of their nourishment. And therefore if the consumption, growing from the weakness of the stomach, do force you to use wine, let it always be burnt, that the quicker spirits may evaporate; or, at the least, quenched with two little wedges of gold, six or seven times repeated. Add also this provision, that there be not too much expence of the nourishment, by exhaling and sweating; and therefore if the patient be apt to sweat, it must be gently restrained. But chiefly Hippocrates's rule is to be followed, who adviseth quite contrary to that which is in use: namely, that the linen or garment next the flesh be, in winter, dry and oft changed; and in summer seldom changed, and smeared over with oil; for certain it is, that any substance that is fat, doth

a little fill the pores of the body, and stay sweat in some degree: but the more cleanly way is, to have the linen smeared lightly over with oil of sweet almonds; and not to forbear shifting as oft as is fit.

56. The second means is, to send forth the nourishment into the parts more strongly; for which the working must be by strengthening of the stomach; and in this, because the stomach is chiefly comforted by wine and hot things, which otherwise hurt, it is good to resort to outward applications to the stomach: Wherein it hath been tried, that the quilts of roses, spices, mastic, wormwood, mint, &c. are nothing so helpful, as to take a cake of new bread, and to bedew it with a litte sack, or Alicant, and to dry it, and after it be dried a little before the fire, to put it within a clean napkin, and to lay it to the stomach; for it is certain, that all flour hath a potent virtue of astriction; in so much as it hardeneth a piece of flesh, or a flower, that is laid in it: and therefore a bag quilted with bran is likewise very good; but it drieth somewhat too much, and therefore it must not lie long.

57. The third means, which may be a branch of the former, is to send forth the nourishment the better by sleep. For we see, that bears, and other creatures that sleep in the winter, wax exceeding fat: and certain it is, as it is commonly believed, that sleep doth nourish much, both for that the spirits do less spend the nourishment in sleep, than when living creatures are awake, and because, that which is to the present purpose, it helpeth to thrust

out the nourishment into the parts. Therefore in aged men, and weak bodies, and such as abound not with choler, a short sleep after dinner doth help to nourish; for in such bodies there is no fear of an over-hasty digestion, which is the inconvenience of postmeridian sleeps. Sleep also in the morning, after the taking of somewhat of easy digestion, as milk from the cow, nourishing broth, or the like, doth further nourishment: but this would be done sitting upright, that the milk or broth may pass the more speedily to the bottom of the stomach.

58. The fourth means is, to provide that the parts themselves may draw to them the nourishment strongly. There is an excellent observation of Aristotle; that a great reason, why plants, some of them, are of greater age than living creatures, is, for that they yearly put forth new leaves and boughs: whereas living creatures put forth, after their period of growth, nothing that is young, but hair and nails, which are excrements, and no parts. And it is most certain, that whatsoever is young, doth draw nourishment better than that which is old; and then, that which is the mystery of that observation, young boughs, and leaves, calling the sap up to them, the same nourisheth the body in the passage. And this we see notably proved also, in that the oft cutting, or polling of hedges, trees, and herbs, doth conduce much to their lasting. Transfer therefore this observation to the helping of nourishment in living creatures: the noblest and principal use whereof is, for the prolongation of life; restoration of some

degree of youth, and inteneration of the parts; for certain it is, that there are in living creatures parts that nourish and repair easily, and parts that nourish and repair hardly: and you must refresh and renew those that are easy to nourish, that the other may be refreshed, and, as it were, drink in nourishment in the passage. Now we see that draught oxen, put into good pasture, recover the flesh of young beef; and men after long emaciating diets wax plump and fat, and almost new: so that you may surely conclude, that the frequent and wise use of those emaciating diets, and of purgings, and perhaps of some kind of bleeding, is a principal means of prolongation of life, and restoring some degree of youth: for as we have often said, death cometh upon living creatures like the torment of Mezentius:

> Mortua quin etiam jungebat corpora vivis
> Componens manibusque manus, atque oribus ora.
>
> Æn. viii. 485.

For the parts in man's body easily reparable, as spirits, blood, and flesh, die in the embracement of the parts hardly reparable, as bones, nerves, and membranes; and likewise some entrails, which they reckon amongst the spermatical parts, are hard to repair: though that division of spermatical and menstrual parts be but a conceit. And this same observation also may be drawn to the present purpose of nourishing emaciated bodies: and therefore gentle frication draweth forth the nourishment,

by making the parts a little hungry, and heating them; whereby they call forth nourishment the better. This frication I wish to be done in the morning. It is also best done by the hand, or a piece of scarlet wool, wet a little with the oil of almonds, mingled with a small quantity of bay-salt, or saffron: we see that the very currying of horses doth make them fat, and in good liking.

59. The fifth means is, to further the very act of assimilation of nourishment; which is done by some outward emolliments, that make the parts more apt to assimilate. For which I have compounded an ointment of excellent odour, which I call Roman ointment; vide the receipt. The use of it would be between sleeps; for in the latter sleep the parts assimilate chiefly.

Experiment solitary touching "Filum medicinale."

60. There be many medicines, which by themselves would do no cure, but perhaps hurt; but being applied in a certain order, one after another, do great cures. I have tried, myself, a remedy for the gout, which hath seldom failed, but driven it away in twenty-four hours space: it is first to apply a poultis, of which vide the receipt, and then a bath, or fomentation, of which vide the receipt; and then a plaister, vide the receipt. The poultis relaxeth the pores, and maketh the humour apt to exhale. The fomentation calleth forth the humour by vapours; but yet in regard of the way made by the poultis, draweth gently; and therefore draweth the humour

out, and doth not draw more to it; for it is a gentle fomentation, and hath withal a mixture, though very little, of some stupefactive. The plaister is a moderate astringent plaister, which repelleth new humour from falling. The poultis alone would make the part more soft and weak, and apter to take the defluxion and impression of the humour. The fomentation alone, if it were too weak, without way made by the poultis, would draw forth little; if too strong, it would draw to the part, as well as draw from it. The plaister alone would pen the humour already contained in the part, and so exasperate it, as well as forbid new humour. Therefore they must be all taken in order, as is said. The poultis is to be laid to for two or three hours: the fomentation for a quarter of an hour, or somewhat better, being used hot, and seven or eight times repeated: the plaister to continue on still, till the part be well confirmed.

Experiment solitary touching cure by custom.

61. There is a secret way of cure, unpractised, by assuetude of that which in itself hurteth. Poisons have been made, by some, familiar, as hath been said. Ordinary keepers of the sick of the plague are seldom infected. Enduring of tortures, by custom, hath been made more easy: the brooking of enormous quantity of meats, and so of wine or strong drink, hath been, by custom, made to be without surfeit or drunkenness. And generally, diseases that are chronical, as coughs, phthisics, some kinds

of palsies, lunacies, &c. are most dangerous at the first: therefore a wise physician will consider whether a disease be incurable; or whether the just cure of it be not full of peril; and if he find it to be such, let him resort to palliation; and alleviate the symptom, without busying himself too much with the perfect cure: and many times, if the patient be indeed patient, that course will exceed all expectation. Likewise the patient himself may strive, by little and little, to overcome the symptom in the acerbation, and so, by time, turn suffering into nature.

Experiment solitary touching cure by excess.

62. Divers diseases, especially chronical, such as quartan agues, are sometimes cured by surfeit and excesses: as excess of meat, excess of drink, extraordinary fasting, extraordinary stirring or lassitude, and the like. The cause is, for that diseases of continuance get an adventitious strength from custom, besides their material cause from the humours; so that the breaking of the custom doth leave them only to their first cause; which if it be any thing weak will fall off. Besides, such excesses do excite and spur nature, which thereupon rises more forcibly against the disease.

Experiment solitary touching cure by motion of consent.

63. There is in the body of man a great consent in the motion of the several parts. We see, it is children's sport, to prove whether they can rub upon

their breast with one hand, and pat upon their forehead with another; and straightways they shall sometimes rub with both hands, or pat with both hands. We see, that when the spirits that come to the nostrils expel a bad scent, the stomach is ready to expel by vomit. We find that in consumptions of the lungs, when nature cannot expel by cough, men fall into fluxes of the belly, and then they die. So in pestilent diseases, if they cannot be expelled by sweat, they fall likewise into looseness; and that is commonly mortal. Therefore physicians should ingeniously contrive, how by emotions that are in their power, they may excite inward motions that are not in their power, by consent: as by the stench of feathers, or the like, they cure the rising of the mother.

Experiment solitary touching cure of diseases which are contrary to predisposition.

64. Hippocrates' aphorism, "in morbis minus," is a good profound aphorism. It importeth, that diseases, contrary to the complexion, age, sex, season of the year, diet, &c. are more dangerous than those that are concurrent. A man would think it should be otherwise; for that, when the accident of sickness, and the natural disposition, do second the one the other, the disease should be more forcible: and so, no doubt, it is, if you suppose like quantity of matter. But that which maketh good the aphorism is, because such diseases do shew a greater collection of matter, by that they are able to overcome

those natural inclinations to the contrary. And therefore in diseases of that kind, let the physician apply himself more to purgation than to alteration; because the offence is in the quantity; and the qualities are rectified of themselves.

Experiment solitary touching preparations before purging, and settling of the body afterwards.

65. Physicians do wisely prescribe, that there be preparatives used before just purgations; for certain it is, that purgers do many times great hurt, if the body be not accommodated, both before and after the purging. The hurt that they do, for want of preparation before purging, is by the sticking of the humours, and their not coming fair away, which causeth in the body great perturbations and ill accidents during the purging; and also the diminishing and dulling of the working of the medicine itself, that it purgeth not sufficiently: therefore the work of preparation is double; to make the humours fluid and mature, and to make the passages more open: for both those help to make the humours pass readily. And for the former of these, syrups are most profitable; and for the latter, apozemes, or preparing broths; clysters also help, lest the medicine stop in the guts, and work gripingly. But it is true, that bodies abounding with humours, and fat bodies, and open weather, are preparatives in themselves; because they make the humours more fluid. But let a physician beware, how he purge after hard frosty weather, and in a lean body, without prepa-

ration. For the hurt that they may do after purging, it is caused by the lodging of some humours in ill places: for it is certain, that there be humours, which somewhere placed in the body, are quiet, and do little hurt; in other places, especially passages, do much mischief. Therefore it is good, after purging, to use apozemes and broths, not so much opening as those used before purging; but abstersive and mundifying clysters also are good to conclude with, to draw away the reliques of the humours, that may have descended to the lower region of the body.

Experiment solitary touching stanching of blood.

66. Blood is stanched divers ways. First, by astringents, and repercussive medicines. Secondly, by drawing of the spirits and blood inwards, which is done by cold, as iron or a stone laid to the neck doth stanch the bleeding at the nose; also it hath been tried, that the testicles being put into sharp vinegar, hath made a sudden recess of the spirits, and stanched blood. Thirdly, by the recess of the blood by sympathy. So it hath been tried, that the part that bleedeth, being thrust into the body of a capon or sheep, new ript and bleeding, hath stanched blood, as it seemeth, sucking and drawing up, by similitude of substance, the blood it meeteth with, and so itself going back. Fourthly, by custom and time; so the Prince of Orange, in his first hurt by the Spanish boy, could find no means to stanch the blood either by medicine or ligament; but was fain

to have the orifice of the wound stopped by mens' thumbs, succeeding one another, for the space at the least of two days; and at the last the blood by custom only retired. There is a fifth way also in use, to let blood in an adverse part, for a revulsion.

Experiment solitary touching change of aliments and medicines.

67. It helpeth, both in medicine and aliment, to change and not to continue the same medicine and aliment still. The cause is, for that nature, by continual use of any thing, groweth to a satiety and dullness, either of appetite or working. And we see that assuetude of things hurtful doth make them lose their force to hurt; as poison, which with use some have brought themselves to brook. And therefore it is no marvel, though things helpful by custom lose their force to help: I count intermission almost the same thing with change; for that, that hath been intermitted, is after a sort new.

Experiment solitary touching diets.

68. It is found by experience, that in diets of guaiacum, sarza, and the like, especially if they be strict, the patient is more troubled in the beginning than after continuance; which hath made some of the more delicate sort of patients give them over in the midst; supposing that if those diets trouble them so much at first, they shall not be able to endure them to the end. But the cause is, for that all those diets to dry up humours, rheums, and the like;

and they cannot dry up until they have first attenuated; and while the humour is attenuated, it is more fluid than it was before, and troubleth the body a great deal more, until it be dried up and consumed. And therefore patients must expect a due time, and not kick at them at the first.

Experiments in consort touching the production of cold.

The producing of cold is a thing very worthy the inquisition; both for use and disclosure of causes. For heat and cold are nature's two hands, whereby she chiefly worketh; and heat we have in readiness, in respect of the fire; but for cold we must stay till it cometh, or seek it in deep caves, or high mountains: and when all is done, we cannot obtain it in any great degree: for furnaces of fire are far hotter than a summer's sun; but vaults or hills are not much colder than a winter's frost.

69. The first means of producing cold, is that which nature presenteth us withal: namely, the expiring of cold out of the inward parts of the earth in winter, when the sun hath no power to overcome it; the earth being, as hath been noted by some, "primum frigidum." This hath been asserted, as well by ancient as by modern philosophers: it was the tenet of Parmenides. It was the opinion of the author of the discourse in Plutarch, for I take it that book was not Plutarch's own, "De primo frigido." It was the opinion of Telesius, who hath renewed the philosophy of Parmenides, and is the best of the novelists.

70. The second cause of cold is the contact of cold bodies; for cold is active and transitive into bodies adjacent, as well as heat: which is seen in those things that are touched with snow or cold water. And therefore, whosoever will be an inquirer into nature, let him resort to a conservatory of snow and ice, such as they use for delicacy to cool wine in summer: which is a poor and contemptible use, in respect of other uses, that may be made of such conservatories.

71. The third cause is the primary nature of all tangible bodies: for it is well to be noted, that all things whatsoever, tangible, are of themselves cold; except they have an accessory heat by fire, life, or motion: for even the spirit of wine, or chemical oils, which are so hot in operation, are to the first touch cold; and air itself compressed, and condensed a little by blowing, is cold.

72. The fourth cause is the density of the body; for all dense bodies are colder than most other bodies, as metals, stone, glass, and they are longer in heating than softer bodies. And it is certain, that earth, dense, tangible, hold all of the nature of cold. The cause is, for that all matters tangible being cold, it must needs follow, that where the matter is most congregate, the cold is the greater.

73. The fifth cause of cold, or rather of increase and vehemency of cold, is a quick spirit inclosed in a cold body: as will appear to any that shall attentively consider of nature in many instances. We see nitre, which hath a quick spirit, is cold; more

cold to the tongue than a stone; so water is colder than oil, because it hath a quicker spirit: for all oil, though it hath the tangible parts better digested than water, yet hath it a duller spirit: so snow is colder than water because it hath more spirit within it: so we see that salt put to ice, as in the producing of artificial ice, increaseth the activity of cold: so some "insecta," which have spirit of life, as snakes and silk-worms, are to the touch cold: so quicksilver is the coldest of metals, because it is fullest of spirit.

74. The sixth cause of cold is the chasing and driving away of spirits such as have some degree of heat: for the banishing of the heat must needs leave any body cold. This we see in the operation of opium and stupefactives upon the spirits of living creatures: and it were not amiss to try opium, by laying it upon the top of a weather-glass, to see whether it will contract the air: but I doubt it will not succeed; for besides that the virtue of opium will hardly penetrate through such a body as glass, I conceive that opium, and the like, make the spirits fly rather by malignity, than by cold.

75. Seventhly, the same effect must follow upon the exhaling or drawing out of the warm spirits, that doth upon the flight of the spirits. There is an opinion, that the moon is magnetical of heat, as the sun is of cold and moisture: it were not amiss therefore to try it, with warm waters; the one exposed to the beams of the moon, the other with some skreen betwixt the beams of the moon and the water, as we use to the sun for shade: and to see

whether the former will cool sooner. And it were also good to inquire, what other means there may be to draw forth the exile heat which is in the air; for that may be a secret of great power to produce cold weather.

Experiments in consort, touching the version and transmutation of air into water.

We have formerly set down the means of turning air into water, in the experiment 27. But because it is "magnale naturæ," and tendeth to the subduing of a very great effect, and is also of manifold use, we will add some instances in consort that give light thereunto.

76. It is reported by some of the ancients, that sailors have used, every night, to hang fleeces of wool on the sides of their ships, the wool towards the water; and that they have crushed fresh water out of them, in the morning, for their use. And thus much we have tried, that a quantity of wool tied loose together, being let down into a deep well, and hanging in the middle, some three fathom from the water, for a night, in the winter time; increased in weight, as I now remember, to a fifth part.

77. It is reported by one of the ancients, that in Lydia, near Pergamus, there were certain workmen in time of wars fled into caves; and the mouth of the caves being stopped by the enemies, they were famished. But long time after the dead bones were found; and some vessels which they had carried with them; and the vessels full of water; and that water thicker, and more towards ice, than com-

mon water: which is a notable instance of condensation and induration by burial under earth, in caves, for long time; and of version also, as it should seem, of air into water; if any of those vessels were empty. Try therefore a small bladder hung in snow, and the like in nitre, and the like in quicksilver: and if you find the bladders fallen or shrunk, you may be sure the air is condensed by the cold of those bodies, as it would be in a cave under earth.

78. It is reported of very good credit, that in the East Indies, if you set a tub of water open in a room where cloves are kept, it will be drawn dry in twenty-four hours; though it stand at some distance from the cloves. In the country, they use many times, in deceit, when their wool is new shorn, to set some pails of water by in the same room, to increase the weight of the wool. But it may be, that the heat of the wool, remaining from the body of the sheep, or the heat gathered by the lying close of the wool, helpeth to draw the watery vapour: but that is nothing to the version.

79. It is reported also credibly, that wool new shorn, being laid casually upon a vessel of verjuice, after some time, had drunk up a great part of the verjuice, though the vessel were whole without any flaw, and had not the bung-hole open. In this instance, there is, upon the by, to be noted, the percolation or suing of the verjuice through the wood; for verjuice of itself would never have passed through the wood: so as, it seemeth, it must be first in a kind of vapour, before it pass.

80. It is especially to be noted, that the cause that doth facilitate the version of air into water, when the air is not in gross, but subtilly mingled with tangible bodies, is, as hath been partly touched before, for that tangible bodies have an antipathy with air; and if they find any liquid body that is more dense near them, they will draw it: and after they have drawn it, they will condense it more, and in effect incorporate it; for we see that a spunge, or wool, or sugar, or a woollen cloth, being put but in part in water or wine, will draw the liquor higher, and beyond the place where the water or wine cometh. We see also, that wood, lute strings, and the like, do swell in moist seasons; as appeareth by the breaking of the strings, the hard turning of the pegs, and the hard drawing forth of boxes, and opening of wainscot doors: which is a kind of infusion: and is much like to an infusion in water, which will make wood to swell; as we see in the filling of the chops of bowls, by laying them in water. But for that part of these experiments which concerneth attraction, we will reserve it to the proper title of attraction.

81. There is also a version of air into water seen in the sweating of marbles and other stones; and of wainscot before and in moist weather. This must be, either by some moisture the body yieldeth, or else by the moist air thickened against the hard body. But it is plain, that it is the latter; for that we see wood painted with oil-colour, will sooner gather drops in a moist night, than wood alone, which

is caused by the smoothness and closeness, which letteth in no part of the vapour, and so turneth it back, and thickeneth it into dew. We see also, that breathing upon a glass, or smooth body, giveth a dew; and in frosty mornings, such as we call rime frosts, you shall find drops of dew upon the inside of glass windows; and the frost itself upon the ground is but a version or condensation of the moist vapours of the night, into a watery substance: dews likewise, and rain, are but the returns of moist vapours condensed; the dew, by the cold only of the sun's departure, which is the gentler cold; rains, by the cold of that which they call the middle region of the air; which is the more violent cold.

82. It is very probable, as hath been touched, that that which will turn water into ice, will likewise turn air some degree nearer unto water. Therefore try the experiment of the artificial turning water into ice, whereof we shall speak in another place, with air in place of water, and the ice about it. And although it be a greater alteration to turn air into water, than water into ice; yet there is this hope, that by continuing the air longer time, the effect will follow: for that artificial conversion of water into ice, is the work of a few hours; and this of air may be tried by a month's space, or the like.

Experiments in consort touching induration of bodies.

Induration, or lapidification of substances more soft, is likewise another degree of condensation; and is a great alteration in nature. The effecting and

accelerating thereof is very worthy to be inquired. It is effected by three means. The first is by cold; whose property is to condense and constipate, as hath been said. The second is by heat; which is not proper but by consequence; for the heat doth attenuate; and by attenuation doth send forth the spirit and moister part of a body; and upon that, the more gross of the tangible parts do contract and sear themselves together; both to avoid "vacuum," as they call it, and also to munite themselves against the force of the fire, which they have suffered. And the third is by assimilation; when a hard body assimilateth a soft, being contiguous to it.

The examples of induration, taking them promiscuously, are many: as the generation of stones within the earth, which at the first are but rude earth or clay: and so of minerals, which come, no doubt, at first of juices concrete, which afterwards indurate: and so of porcelain, which is an artificial cement, buried in the earth a long time; and so the making of brick and tile: also the making of glass of a certain sand and brake-roots, and some other matters; also the exudations of rock-diamonds and crystal, which harden with time; also the induration of bead-amber, which at first is a soft substance; as appeareth by the flies and spiders which are found in it; and many more: but we will speak of them distinctly.

83. For indurations by cold, there be few trials of it; for we have no strong or intense cold here on the surface of the earth, so near the beams of the

sun, and the heavens. The likeliest trial is by snow and ice; for as snow and ice, especially being holpen and their cold activated by nitre, or salt, will turn water into ice, and that in a few hours; so it may be, it will turn wood or stiff clay into stone, in longer time. Put therefore into a conserving pit of snow and ice, adding some quantity of salt and nitre, a piece of wood, or a piece of tough clay, and let it lie a month or more.

84. Another trial is by metalline waters, which have virtual cold in them. Put therefore wood or clay into smith's water, or other metalline water, and try whether it will not harden in some reasonable time. But I understand it of metalline waters that come by washing or quenching; and not of strong waters that come by dissolution; for they are too corrosive to consolidate.

85. It is already found that there are some natural spring waters, that will inlapidate wood; so that you shall see one piece of wood, whereof the part above the water shall continue wood; and the part under water shall be turned into a kind of gravelly stone. It is likely those waters are of some metalline mixture; but there would be more particular inquiry made of them. It is certain, that an egg was found, having lain many years in the bottom of a mote, where the earth had somewhat overgrown it; and this egg was come to the hardness of a stone, and had the colours of the white and yolk perfect, and the shell shining in small grains like sugar or alabaster.

86. Another experience there is of induration by cold, which is already found; which is, that metals themselves are hardened by often heating and quenching in cold water: for cold ever worketh most potently upon heat precedent.

87. For induration by heat, it must be considered, that heat, by the exhaling of the moister parts, doth either harden the body, as in bricks, tiles, &c. or if the heat be more fierce, maketh the grosser part itself run and melt; as in the making of ordinary glass; and in the vitrification of earth, as we see in the inner parts of furnaces, and in the vitrification of brick, and of metals. And in the former of these, which is the hardening by baking without melting, the heat hath these degrees; first, it indurateth, and then maketh fragile; and lastly it doth incinerate and calcinate.

88. But if you desire to make an induration with toughness, and less fragility, a middle way would be taken; which is that which Aristotle hath well noted; but would be thoroughly verified. It is to decoct bodies in water for two or three days; but they must be such bodies into which the wate will not enter; as stone and metal; for if they be bodies into which the water will enter, then long seething will rather soften than indurate them; as hath been tried in eggs, &c. therefore softer bodies must be put into bottles, and the bottles hung into water seething with the mouths open above the water, that no water may get in; for by this means the virtual heat of the water will enter; and such a heat, as

will not make the body adust or fragile; but the substance of the water will be shut out. This experiment we made; and it sorted thus. It was tried with a piece of free-stone, and with pewter, put into the water at large. The free-stone we found received in some water; for it was softer and easier to scrape than a piece of the same stone kept dry. But the pewter, into which no water could enter, became more white, and liker to silver, and less flexible by much. There were also put into an earthen bottle, placed as before, a good pellet of clay, a piece of cheese, a piece of chalk, and a piece of free-stone. The clay came forth almost of the hardness of stone; the cheese likewise very hard, and not well to be cut; the chalk and the free-stone much harder than they were. The colour of the clay inclined not a whit to the colour of brick, but rather to white, as in ordinary drying by the sun. Note, that all the former trials were made by a boiling upon a good hot fire, renewing the water as it consumed, with other hot water; but the boiling was but for twelve hours only; and it is like that the experiment would have been more effectual, if the boiling had been for two or three days, as we prescribed before.

89. As touching assimilation for this is a degree of assimilation even in inanimate bodies, we see examples of it in some stones in clay-grounds, lying near to the top of the earth, where pebble is; in which you may manifestly see divers pebbles gathered together, and a crust of cement or

stone between them, as hard as the pebbles themselves; and it were good to make a trial of purpose, by taking clay, and putting in it divers pebble stones, thick set, to see whether in continuance of time, it will not be harder than other clay of the same lump, in which no pebbles are set. We see also in ruins of old walls, especially towards the bottom, the mortar will become as hard as the brick: we see also, that the wood on the sides of vessels of wine, gathereth a crust of tartar, harder than the wood itself; and scales likewise grow to the teeth, harder than the teeth themselves.

90. Most of all, induration by assimilation appeareth in the bodies of trees and living creatures: for no nourishment that the tree receiveth, or that the living creature receiveth, is so hard as wood, bone, or horn, &c. but is indurated after by assimilation.

Experiment solitary touching the version of water into air.

91. The eye of the understanding is like the eye of the sense: for as you may see great objects through small crannies, or levels; so you may see great axioms of nature through small and contemptible instances. The speedy depredation of air upon watery moisture, and version of the same into air, appeareth in nothing more visible, than in the sudden discharge or vanishing of a little cloud of breath or vapour from glass, or the blade of a sword, or any such polished body, such as doth not at all detain

or imbibe the moisture; for the mistiness scattereth and breaketh up suddenly. But the like cloud, if it were oily or fatty, will not discharge; not because it sticketh faster; but because air preyeth upon water; and flame and fire upon oil; and therefore to take out a spot of grease they use a coal upon brown paper; because fire worketh upon grease or oil, as air doth upon water. And we see paper oiled, or wood oiled, or the like, last long moist; but wet with water, dry or putrify sooner. The cause is, for that air meddleth little with the moisture of oil.

Experiment solitary touching the force of union.

92. There is an admirable demonstration in the same trifling instance of the little cloud upon glass, or gems, or blades of swords, of the force of union, even in the least quantities, and weakest bodies, how much it conduceth to preservation of the present form, and the resisting of a new. For mark well the discharge of that cloud; and you shall see it ever break up, first in the skirts, and last in the midst. We see likewise, that much water draweth forth the juice of the body infused; but little water is imbibed by the body: and this is a principal cause, why in operation upon bodies for their version or alteration, the trial in great quantities doth not answer the trial in small; and so deceiveth many; for that, I say, the greater body resisteth more any alteration of form, and requireth far greater strength in the active body that should subdue it.

Experiment solitary touching the producing of feathers and hairs of divers colours.

93. We have spoken before, in the fifth instance, of the cause of orient colours in birds; which is by the fineness of the strainer; we will now endeavour to reduce the same axiom to a work. For this writing of our "Sylva Sylvarum" is, to speak properly, not natural history, but a high kind of natural magic. For it is not a description only of nature, but a breaking of nature into great and strange works. Try therefore the anointing over of pigeons, or other birds, when they are but in their down; or of whelps, cutting their hair as short as may be; or of some other beast; with some ointment that is not hurtful to the flesh, and that will harden and stick very close; and see whether it will not alter the colours of the feathers or hair. It is received, that the pulling off the first feathers of birds clean, will make the new come forth white: and it is certain that white is a penurious colour, and where moisture is scant. So blue violets, and other flowers, if they be starved, turn pale and white; birds and horses, by age or scars, turn white: and the hoar hairs of men come by the same reason. And therefore in birds, it is very likely, that the feathers that come first will be many times of divers colours, according to the nature of the bird, for that the skin is more porous; but when the skin is more shut and close, the feathers will come white. This is a good experiment,

not only for the producing of birds and beasts of strange colours; but also for the disclosure of the nature of colours themselves: which of them require a finer porosity, and which a grosser.

Experiment solitary touching the nourishment of living creatures before they be brought forth.

94. It is a work of providence, that hath been truly observed by some, that the yolk of the egg conduceth little to the generation of the bird, but only to the nourishment of the same; for if a chicken be opened, when it is new hatched, you shall find much of the yolk remaining. And it is needful, that birds that are shaped without the female's womb have in the egg, as well matter of nourishment, as matter of generation for the body. For after the egg is laid, and severed from the body of the hen, it hath no more nourishment from the hen, but only a quickening heat when she sitteth. But beasts and men need not the matter of nourishment within themselves, because they are shaped within the womb of the female, and are nourished continually from her body.

Experiments in consort touching sympathy and antipathy for medicinal use.

95. It is an inveterate and received opinion, that cantharides applied to any part of the body, touch the bladder and exulcerate it, if they stay on long. It is likewise received, that a kind of stone, which they bring out of the West-Indies, hath a peculiar

force to move gravel, and to dissolve the stone: insomuch, as laid but to the wrist, it hath so forcibly sent down gravel, as men have been glad to remove it, it was so violent.

96. It is received, and confirmed by daily experience, that the soles of the feet have great affinity with the head and the mouth of the stomach; as we see going wet-shod, to those that use it not, affecteth both: applications of hot powders to the feet attenuate first, and after dry the rheum: and therefore a physician that would be mystical, prescribeth, for the cure of the rheum, that a man should walk continually upon a camomile-alley; meaning, that he should put camomile within his socks. Likewise pigeons bleeding, applied to the soles of the feet, ease the head: and soporiferous medicines applied unto them, provoke sleep.

97. It seemeth, that as the feet have a sympathy with the head, so the wrists and hands have a sympathy with the heart; we see the affects and passions of the heart and spirits are notably disclosed by the pulse: and it is often tried, that juices of stock-gilly-flowers, rose-campian, garlick, and other things, applied to the wrists, and renewed, have cured long agues. And I conceive, that washing with certain liquors the palms of the hands doth much good: and they do well in heats of agues, to hold in the hands eggs of alabaster and balls of crystal.

Of these things we shall speak more, when we handle the title of sympathy and antipathy in the proper place.

Experiment solitary touching the secret processes of nature.

98. The knowledge of man hitherto hath been determined by the view or sight; so that whatsoever is invisible, either in respect of the fineness of the body itself, or the smallness of the parts, or of the subtilty of the motion, is little inquired. And yet these be the things that govern nature principally; and without which you cannot make any true analysis and indication of the proceedings of nature. The spirits or pneumaticals, that are in all tangible bodies, are scarce known. Sometimes they take them for "vacuum;" whereas they are the most active of bodies. Sometimes they take them for air; from which they differ exceedingly, as much as wine from water; and as wood from earth. Sometimes they will have them to be natural heat, or a portion of the element of fire; whereas some of them are crude and cold. And sometimes they will have them to be the virtues and qualities of the tangible parts which they see; whereas they are things by themselves. And then, when they come to plants and living creatures, they call them souls. And such superficial speculations they have; like prospectives, that shew things inward, when they are but paintings. Neither is this a question of words, but infinitely material in nature. For spirits are nothing else but a natural body, rarified to a proportion, and included in the tangible parts of bodies, as in an integument. And they be no less differing one from

the other, than the dense or tangible parts; and they are in all tangible bodies whatsoever, more or less; and they are never almost at rest; and from them, and their motions, principally proceed arefaction, colliquation, concoction, maturation, putrefaction, vivification, and most of the effects of nature: for, as we have figured them in our "Sapientia Veterum," in the fable of Proserpina, you shall in the infernal regiment hear little doings of Pluto, but most of Proserpina: for tangible parts in bodies, are stupid things; and the spirits do in effect all. As for the differences of tangible parts in bodies, the industry of the chemists hath given some light, in discerning by their separations the oily, crude, pure, impure, fine, gross parts of bodies, and the like. And the physicians are content to acknowledge, that herbs and drugs have divers parts; as that opium hath a stupefactive part, and a heating part; the one moving sleep, the other a sweat following; and that rhubarb hath purging parts, and astringent parts, &c. But this whole inquisition is weakly and negligently handled. And for the more subtle differences of the minute parts, and the posture of them in the body, which also hath great effects, they are not at all touched: as for the motions of the minute parts of bodies, which do so great effects, they have not been observed at all; because they are invisible, and incur not to the eye; but yet they are to be deprehended by experience: as Democritus said well, when they charged him to hold, that the world was made of such little motes, as were

seen in the sun: "Atomus," saith he, "necessitate "rationis et experientiæ esse convincitur; atomum "enim nemo unquam vidit." And therefore the tumult in the parts of solid bodies, when they are compressed, which is the cause of all flight of bodies through the air, and of other mechanical motions, as hath been partly touched before, and shall be throughly handled in due place, is not seen at all. But nevertheless, if you know it not, or inquire it not attentively and diligently, you shall never be able to discern, and much less to produce, a number of mechanical motions. Again, as to the motions corporal, within the inclosures of bodies, whereby the effects, which were mentioned before, pass between the spirits and the tangible parts, which are arefaction, colliquation, concoction, maturation, &c. they are not at all handled. But they are put off by the names of virtues, and natures, and actions, and passions, and such other logical words.

Experiment solitary touching the power of heat.

99. It is certain, that of all powers in nature heat is the chief; both in the frame of nature, and in the works of art. Certain it is likewise, that the effects of heat are most advanced, when it worketh upon a body without loss or dissipation of the matter; for that ever betrayeth the account. And therefore it is true, that the power of heat is best perceived in distillations which are performed in close vessels and receptacles. But yet there is a higher degree; for howsoever distillations do keep

the body in cells and cloisters, without going abroad, yet they give space unto bodies to turn into vapour; to return into liquor, and to separate one part from another. So as nature doth expatiate, although it hath not full liberty: whereby the true and ultime operations of heat are not attained. But if bodies may be altered by heat, and yet no such reciprocation of rarefaction, and of condensation, and of separation, admitted, then it is like that this Proteus of matter, being held by the sleeves, will turn and change into many metamorphoses. Take therefore a square vessel of iron, in form of a cube, and let it have good thick and strong sides. Put into it a cube of wood, that may fill it as close as may be, and let it have a cover of iron, as strong at least as the sides, and let it be well luted, after the manner of the chemists. Then place the vessel within burning coals, kept quick kindled for some few hours' space. Then take the vessel from the fire, and take off the cover, and see what is become of the wood. I conceive, that since all inflammation and evaporation are utterly prohibited, and the body still turned upon itself, that one of these two effects will follow: either that the body of the wood will be turned into a kind of "amalgama," as the chemists call it, or that the finer part will be turned into air, and the grosser stick as it were baked, and incrustate upon the sides of the vessel, being become of a denser matter than the wood itself crude. And for another trial, take also water, and put it in the like vessel, stopped as before, but

use a gentler heat, and remove the vessel sometimes from the fire; and again, after some small time, when it is cold, renew the heating of it; and repeat this alteration some few times: and if you can once bring to pass, that the water, which is one of the simplest of bodies, be changed in colour, odour, or taste, after the manner of compound bodies, you may be sure that there is a great work wrought in nature, and a notable entrance made into strange changes of bodies and productions; and also a way made to do that by fire, in small time, which the sun and age do in long time. But of the admirable effects of this distillation in close, (for so we call it,) which is like the wombs and matrices of living creatures, where nothing expireth nor separateth we will speak fully, in the due place; not that we aim at the making of Paracelsus's pygmies, or any such prodigious follies; but that we know the effects of heat will be such, as will scarce fall under the conceit of man, if the force of it be altogether kept in.

Experiment solitary touching the impossibility of annihilation.

100. There is nothing more certain in nature than that it is impossible for any body to be utterly annihilated; but that as it was the work of the omnipotency of God to make somewhat of nothing, so it requireth the like omnipotency to turn somewhat into nothing. And therefore it is well said by an obscure writer of the sect of the chemists, that there

is no such way to effect the strange transmutations of bodies, as to endeavour and urge by all means the reducing of them to nothing. And herein is contained also a great secret of preservation of bodies from change; for if you can prohibit, that they neither turn into air, because no air cometh to them, nor go into the bodies adjacent, because they are utterly heterogeneal; nor make a round and circulation within themselves; they will never change though they be in their nature never so perishable or mutable. We see how flies, and spiders, and the like, get a sepulchre in amber, more durable than the monument and embalming of the body of any king. And I conceive the like will be of bodies put into quicksilver. But then they must be but thin, as a leaf, or a piece of paper or parchment; for if they have a greater crassitude, they will alter in their own body, though they spend not. But of this we shall speak more when we handle the title of conservation of bodies.

NATURAL HISTORY.

CENTURY II.

Experiments in consort touching Music.

Music, in the practice, hath been well pursued, and in good variety; but in the theory, and especially in the yielding of the causes of the practic, very weakly; being reduced into certain mystical subtilties of no use and not much truth. We shall, therefore, after our manner, join the contemplative and active part together.

101. All sounds are either musical sounds, which we call tones; whereunto there may be an harmony; which sounds are ever equal; as singing, the sounds of stringed and wind instruments, the ringing of bells, &c. or immusical sounds, which are ever unequal; such as are the voice in speaking, all whisperings, all voices of beasts and birds, except they be singing-birds, all percussions of stones, wood, parchment, skins, as in drums, and infinite others.

102. The sounds that produce tones, are ever from such bodies as are in their parts and pores equal; as well as the sounds themselves are equal; and such are the percussions of metal, as in

bells; of glass, as in the filliping of a drinking glass; of air, as in men's voices whilst they sing, in pipes, whistles, organs, stringed instruments, &c. and of water, as in the nightingale pipes of regals, or organs, and other hydraulics; which the ancients had, and Nero did so much esteem, but are now lost. And if any man think, that the string of the bow and the string of the viol are neither of them equal bodies, and yet produce tones, he is in an error. For the sound is not created between the bow or "plectrum" and the string; but between the string and the air; no more than it is between the finger or quill, and the string in other instruments. So there are, in effect, but three percussions that create tones; percussions of metals, comprehending glass and the like, percussions of air, and percussions of water.

103. The diapason or eighth in music is the sweetest concord, in so much as it is in effect an unison; as we see in lutes that are strung in the base strings with two strings, one an eighth above another; which make but as one sound. And every eighth note in ascent, as from eight to fifteen, from fifteen to twenty-two, and so in "infinitum," are but scales of diapason. The cause is dark, and hath not been rendred by any; and therefore would be better contemplated. It seemeth that air, which is the subject of sounds, in sounds that are not tones, which are all unequal, as hath been said, admitteth much variety; as we see in the voices of living creatures, and likewise in the voices of several men, for we are

capable to discern several men, by their voices, and in the conjugation of letters, whence articulate sounds proceed; which of all others are most various. But in the sounds which we call tones, that are ever equal, the air is not able to cast itself into any such variety; but is forced to recur into one and the same posture or figure, only differing in greatness and smallness. So we see figures may be made of lines, crooked and straight, in infinite variety, where there is inequality; but circles, or squares, or triangles equilateral, which are all figures of equal lines, can differ but in greater or lesser.

104. It is to be noted, the rather lest any man should think that there is any thing in this number of eight, to create the diapason, that this computation of eight is a thing rather received, than any true computation. For a true computation ought ever to be by distribution into equal portions. Now there be intervenient in the rise of eight, in tones, two beemolls, or half notes: so as if you divide the tones equally, the eight is but seven whole and equal notes; and if you subdivide that into half-notes, as it is in the stops of a lute, it maketh the number of thirteen.

105. Yet this is true, that in the ordinary rises and falls of the voice of man, not measuring the tone by whole notes, and half-notes, which is the equal measure, there fall out to be two beemolls, as hath been said, between the unison and the diapason: and this varying is natural. For if a man would endea-

vour to raise or fall his voice, still by half-notes, like the stops of a lute; or by whole notes alone without halfs, as far as an eighth; he will not be able to frame his voice unto it. Which sheweth, that after every three whole notes, nature requireth, for all harmonical use, one half-note to be interposed.

106. It is to be considered, that whatsoever virtue is in numbers, for conducing to consent of notes, is rather to be ascribed to the ante-number, than to the entire number; as namely, that the sound returneth after six or after twelve; so that the seventh or the thirteenth is not the matter, but the sixth or the twelfth; and the seventh and the thirteenth are but the limits and boundaries of the return.

107. The concords in music which are perfect or semiperfect, between the unison and the diapason, are the fifth, which is the most perfect; the third next; and the sixth, which is more harsh: and, as the ancients esteemed, and so do myself and some other yet, the fourth which they call diatessaron. As for the tenth, twelfth, thirteenth, and so in "infinitum," they be but recurrences of the former, viz. of the third, the fifth, and the sixth; being an eighth respectively from them.

108. For discords, the second and the seventh are of all others the most odious in harmony, to the sense; whereof the one is next above the unison, the other next under the diapason: which may shew that harmony requireth a competent distance of notes.

109. In harmony, if there be not a discord to the base, it doth not disturb the harmony, though there be a discord to the higher parts; so the discord be not of the two that are odious; and therefore the ordinary consent of four parts consisteth of an eighth, a fifth, and a third to the base; but that fifth is a fourth to the treble, and the third is a sixth. And the cause is, for that the base striking more air, doth overcome and drown the treble, unless the discord be very odious; and so hideth a small imperfection. For we see, that in one of the lower strings of a lute, there soundeth not the sound of the treble, nor any mixt sound, but only the sound of the base.

110. We have no music of quarter-notes; and it may be they are not capable of harmony; for we see the half notes themselves do but interpose sometimes. Nevertheless we have some slides or relishes of the voice or strings, as it were continued without notes, from one tone to another, rising or falling, which are delightful.

111. The causes of that which is pleasing or ingrate to the hearing, may receive light by that which is pleasing or ingrate to the sight. There be two things pleasing to the sight, leaving pictures and shapes aside, which are but secondary objects; and please or displease but in memory; these two are colours and order. The pleasing of colour symbolizeth with the pleasing of any single tone to the ear; but the pleasing of order doth symbolize with

harmony. And therefore we see in garden-knots, and the frets of houses, and all equal and well answering figures, as globes, pyramids, cones, cylinders, &c. how they please; whereas unequal figures are but deformities. And both these pleasures, that of the eye, and that of the ear, are but the effects of equality, good proportion, or correspondence: so that, out of question, equality and correspondence are the causes of harmony. But to find the proportion of that correspondence, is more abstruse; whereof notwithstanding we shall speak somewhat, when we handle tones, in the general enquiry of sounds.

112. Tones are not so apt altogether to procure sleep as some other sounds; as the wind, the purling of water, humming of bees, a sweet voice of one that readeth, &c. The cause whereof is, for that tones, because they are equal and slide not, do more strike and erect the sense than the other. And overmuch attention hindereth sleep.

113. There be in music certain figures or tropes, almost agreeing with the figures of rhetoric, and with the affections of the mind, and other senses. First, the division and quavering, which please so much in music, have an agreement with the glittering of light; as the moon-beams playing upon a wave. Again, the falling from a discord to a concord, which maketh great sweetness in music, hath an agreement with the affections, which are reintegrated to the better, after some dislikes; it agreeth also with the taste, which is soon glutted with that which is sweet alone. The sliding from the close or

cadence, hath an agreement with the figure in rhetoric, which they call "præter expectatum;" for there is a pleasure even in being deceived. The reports, and fuges, have an agreement with the figures in rhetoric, of repetition and traduction. The triplas, and changing of times, have an agreement with the changes of motions; as when galliard time, and measure time, are in the medley of one dance.

114. It hath been anciently held and observed, that the sense of hearing, and the kinds of music, have most operation upon manners; as, to encourage men, and make them warlike; to make them soft and effeminate; to make them grave; to make them light; to make them gentle and inclined to pity, &c. The cause is, for that the sense of hearing striketh the spirits more immediately than the other senses; and more incorporeally than the smelling; for the sight, taste, and feeling, have their organs not of so present and immediate access to the spirits, as the hearing hath. And as for the smelling, which indeed worketh also immediately upon the spirits, and is forcible while the object remaineth, it is with a communication of the breath or vapour of the object odorate; but harmony entering easily, and mingling not at all, and coming with a manifest motion, doth by custom of often affecting the spirits, and putting them into one kind of posture, alter not a little the nature of the spirits, even when the object is removed. And therefore we see, that tunes and airs, even in their own nature, have in themselves some affinity with

the affections; as there be merry tunes, doleful tunes, solemn tunes; tunes inclining men's minds to pity; warlike tunes, &c. So as it is no marvel if they alter the spirits, considering that tunes have a predisposition to the motion of the spirits in themselves. But yet it hath been noted, that though this variety of tunes doth dispose the spirits to variety of passions, conform unto them, yet generally music feedeth that disposition of the spirits, which it findeth. We see also, that several airs and tunes do please several nations and persons, according to the sympathy they have with their spirits.

Experiments in consort touching sounds; and first touching the nullity and entity of sounds.

Perspective hath been with some diligence enquired; and so hath the nature of sounds, in some sort, as far as concerneth music: but the nature of sounds in general hath been superficially observed. It is one of the subtilest pieces of nature. And besides, I practise, as I do advise; which is, after long enquiry of things immersed in matter, to interpose some subject which is immateriate, or less materiate; such as this of sounds; to the end, that the intellect may be rectified, and become not partial.

115. It is first to be considered, what great motions there are in nature, which pass without sound or noise. The heavens turn about in a most rapid motion, without noise to us perceived; though in some dreams they have been said to make an excellent music. So the motions of the comets, and fiery

meteors, as " stella cadens," &c. yield no noise. And if it be thought, that it is the greatness of distance from us, whereby the sound cannot be heard; we see that lightnings and coruscations, which are near at hand, yield no sound neither: and yet in all these, there is a percussion and division of the air. The winds in the upper region, which move the clouds above, which we call the rack, and are not perceived below, pass without noise. The lower winds in a plain, except they be strong, make no noise; but amongst trees, the noise of such winds will be perceived. And the winds, generally, when they make a noise, do ever make it unequally, rising and falling, and sometimes, when they are vehement, trembling at the height of their blast. Rain or hail falling, though vehemently, yieldeth no noise in passing through the air, till it fall upon the ground, water, houses, or the like. Water in a river, though a swift stream, is not heard in the channel, but runneth in silence, if it be of any depth; but the very stream upon shallows, of gravel, or pebble, will be heard. And waters, when they beat upon the shore, or are straitned, as in the falls of bridges, or are dashed against themselves, by winds, give a rearing noise. Any piece of timber, or hard body, being thrust forwards by another body contiguous, without knocking, giveth no noise. And so bodies in weighing one upon another, though the upper body press the lower body down, make no noise. So the motion in the minute parts of any solid body, which is the principal cause of violent motion, though unob-

served, passeth without sound; for that sound that is heard sometimes is produced only by the breaking of the air, and not by the impulsion of the parts. So it is manifest, that where the anterior body giveth way, as fast as the posterior cometh on, it maketh no noise, be the motion never so great or swift.

116. Air open, and at large, maketh no noise, except it be sharply percussed; as in the sound of a string, where air is percussed by a hard and stiff body, and with a sharp loose: for if the string be not strained, it maketh no noise. But where the air is pent and straitned, there breath or other blowing, which carry but a gentle percussion, suffice to create sound; as in pipes and wind-instruments. But then you must note, that in recorders, which go with a gentle breath, the concave of the pipe, were it not for the fipple that straitneth the air, much more than the simple concave, would yield no sound. For as for other wind-instruments, they require a forcible breath; as trumpets, cornets, hunters' horns, &c. which appeareth by the blown cheeks of him that windeth them. Organs also are blown with a strong wind by the bellows. And note again, that some kind of wind-instruments are blown at a small hole in the side, which straitneth the breath at the first entrance; the rather, in respect of the traverse and stop above the hole, which performeth the fipple's part; as it is seen in flutes and fifes, which will not give sound by a blast at the end, as recorders, &c. do. Likewise in all whistling,

you contract the mouth; and to make it more sharp, men sometimes use their finger. But in open air, if you throw a stone or a dart, they give no sound; no more do bullets, except they happen to be a little hollowed in the casting; which hollowness penneth the air: nor yet arrows, except they be ruffled in their feathers, which likewise penneth the air. As for small whistles or shepherds oaten pipes, they give a sound because of their extreme slenderness, whereby the air is more pent than in a wider pipe. Again, the voices of men and living creatures pass through the throat, which penneth the breath. As for the Jews-harp, it is a sharp percussion; and besides, hath the advantage of penning the air in the mouth.

117. Solid bodies, if they be very softly percussed, give no sound; as when a man treadeth very softly upon boards. So chests or doors in fair weather, when they open easily, give no sound. And cart-wheels squeak not when they are liquored.

118. The flame of tapers or candles, though it be a swift motion and breaketh the air, yet passeth without sound. Air in ovens, though, no doubt, it doth, as it were, boil and dilate itself, and is repercussed; yet it is without noise.

119. Flame percussed by air giveth a noise; as in blowing of the fire by bellows; greater than if the bellows should blow upon the air it itself. And so likewise flame percussing the air strongly, as when flame suddenly taketh and openeth, giveth a noise;

so great flames, while the one impelleth the other, give a bellowing sound.

120. There is a conceit runneth abroad, that there should be a white powder, which will discharge a piece without noise; which is a dangerous experiment if it should be true: for it may cause secret murders. But it seemeth to me impossible; for if the air pent be driven forth and strike the air open, it will certainly make a noise. As for the white powder, if any such thing be, that may extinguish or dead the noise, it is like to be a mixture of petre and sulphur, without coal. For petre alone will not take fire. And if any man think, that the sound may be extinguished or deaded by discharging the pent air, before it cometh to the mouth of the piece and to the open air, that is not probable; for it will make more divided sounds: as if you should make a cross-barrel hollow through the barrel of a piece, it may be it would give several sounds, both at the nose and at the sides. But I conceive, that if it were possible to bring to pass, that there should be no air pent at the mouth of the piece, the bullet might fly with small or no noise. For first it is certain, there is no noise in the percussion of the flame upon the bullet. Next the bullet, in piercing through the air, maketh no noise as hath been said. And then, if there be no pent air that striketh upon open air, there is no cause of noise; and yet the flying of the bullet will not be stayed. For that motion, as hath been oft said, is in the parts of the bullet, and not in

the air. So as trial must be made by taking some small concave of metal, no more than you mean to fill with powder, and laying the bullet in the mouth of it, half out into the open air.

121. I heard it affirmed by a man that was a great dealer in secrets, but he was but vain, that there was a conspiracy, which himself hindered, to have killed queen Mary, sister to Queen Elizabeth, by a burning-glass, when she walked in St. James's park, from the leads of the house. But thus much, no doubt, is true; that if burning-glasses could be brought to a great strength, as they talk generally of burning-glasses that are able to burn a navy, the percussion of the air alone, by such a burning-glass, would make no noise; no more than is found in coruscations and lightnings without thunders.

122. I suppose, that impression of the air with sounds asketh a time to be conveyed to the sense, as well as the impressing of species visible; or else they will not be heard. And therefore, as the bullet moveth so swift that it is invisible; so the same swiftness of motion maketh it inaudible: for we see, that the apprehension of the eye is quicker than that of the ear.

123. All eruptions of air, though small and slight, give an entity of sound, which we call crackling, puffing, spitting, &c. as in bay-salt, and bay-leaves, cast into the fire; so in chestnuts, when they leap forth of the ashes; so in green wood laid upon the fire, especially roots; so in candles, that spit flame if they be wet; so in rasping, sneezing, &c. so

in a rose leaf gathered together into the fashion of a purse, and broken upon the forehead, or back of the hand, as children use.

Experiments in consort touching production, conservation, and dilation of sounds; and the office of the air therein.

124. The cause given of sound, that it should be an elision of the air, whereby, if they mean any thing, they mean a cutting or dividing, or else an attenuating of the air, is but a term of ignorance; and the notion is but a catch of the wit upon a few instances; as the manner is in the philosophy received. And it is common with men, that if they have gotten a pretty expression by a word of art, that expression goeth current; though it be empty of matter. This conceit of elision appeareth most manifestly to be false, in that the sound of a bell, string, or the like, continueth melting some time after the percussion; but ceaseth straightways, if the bell, or string, be touched and stayed: whereas, if it were the elision of the air that made the sound, it could not be that the touch of the bell or string should extinguish so suddenly that motion caused by the elision of the air. This appeareth yet more manifestly by chiming with a hammer upon the outside of a bell: for the sound will be according to the inward concave of the bell; whereas the elision or attenuation of the air cannot be but only between the hammer and the outside of the bell. So again, if it were an elision, a broad hammer, and a bodkin, struck upon metal, would

give a diverse tone, as well as a diverse loudness; but they do not so; for though the sound of the one be louder, and of the other softer, yet the tone is the same. Besides, in echoes, whereof some are as loud as the original voice, there is no new elision, but a repercussion only. But that which convinceth it most of all is, that sounds are generated where there is no air at all. But these and the like conceits, when men have cleared their understanding by the light of experience, will scatter and break up like a mist.

125. It is certain, that sound is not produced at the first, but with some local motion of the air, or flame, or some other medium; nor yet without some resistance, either in the air or the body percussed. For if there be a mere yielding or cession, it produceth no sound; as hath been said. And therein sounds differ from light and colours, which pass through the air, or other bodies, without any local motion of the air; either at the first, or after. But you must attentively distinguish between the local motion of the air, which is but "vehiculum causæ," a carrier of the sounds, and the sounds themselves, conveyed in the air. For as to the former, we see manifestly, that no sound is produced, no not by air itself against other air, as in organs, &c. but with a perceptible blast of the air; and with some resistance of the air strucken. For even all speech, which is one of the gentlest motions of air, is with expulsion of a little breath. And all pipes have a blast, as well as a sound. We see also manifestly, that sounds are

carried with wind: and therefore sounds will be heard further with the wind, than against the wind; and likewise do rise and fall with the intension or remission of the wind. But for the impression of the sound, it is quite another thing, and is utterly without any local motion of the air, perceptible; and in that resembleth the species visible: for after a man hath lured, or a bell is rung, we cannot discern any perceptible motion at all in the air along as the sound goeth; but only at the first. Neither doth the wind, as far as it carrieth a voice, with the motion thereof, confound any of the delicate and articulate figurations of the air, in variety of words. And if a man speak a good loudness against the flame of a candle, it will not make it tremble much; though most when those letters are pronounced which contract the mouth; as F. S. V. and some others. But gentle breathing, or blowing without speaking, will move the candle far more. And it is the more probable, that sound is without any local motion of the air, because as it differeth from the sight, in that it needeth a local motion of the air at first; so it paralleleth in so many other things with the sight, and radiation of things visible; which without all question, induce no local motion in the air, as hath been said.

126. Nevertheless it is true, that upon the noise of thunder, and great ordnance, glass windows will shake; and fishes are thought to be frayed with the motion caused by noise upon the water. But these effects are from the local motion of the air, which is

a concomitant of the sound, as hath been said, and not from the sound.

127. It hath been anciently reported, and is still received, that extreme applauses and shouting of people assembled in great multitudes, have so rarified and broken the air, that birds flying over have fallen down, the air being not able to support them. And it is believed by some, that great ringing of bells in populous cities hath chased away thunder; and also dissipated pestilent air: all which may be also from the concussion of the air, and not from the sound.

128. A very great sound, near hand, hath strucken many deaf; and at the instant they have found, as it were, the breaking of a skin or parchment in their ear: and myself standing near one that lured loud and shrill, had suddenly an offence, as if somewhat had broken or been dislocated in my ear; and immediately after a loud ringing, not an ordinary singing or hissing, but far louder and differing, so as I feared some deafness. But after some half quarter of an hour it vanished. This effect may be truly referred unto the sound: for as is commonly received, an over-potent object doth destroy the sense; and spiritual species, both visible and audible, will work upon the sensories, though they move not any other body.

129. In dilation of sounds, the inclosure of them preserveth them, and causeth them to be heard further. And we find in rolls of parchment or trunks, the mouth being laid to the one end of the roll of

parchment or trunk, and the ear to the other, the sound is heard much farther than in the open air. The cause is, for that the sound spendeth, and is dissipated in the open air; but in such concaves it is conserved and contracted. So also in a piece of ordnance, if you speak in the touch-hole, and another lay his ear to the mouth of the piece, the sound passeth and is far better heard than in the open air.

130. It is further to be considered, how it proveth and worketh when the sound is not inclosed all the length of its way, but passeth partly through open air; as where you speak some distance from a trunk; or where the ear is some distance from the trunk at the other end; or where both mouth and ear are distant from the trunk. And it is tried, that in a long trunk of some eight or ten foot, the sound is holpen, though both the mouth and the ear be a handful or more from the ends of the trunk; and somewhat more holpen, when the ear of the hearer is near, than when the mouth of the speaker. And it is certain, that the voice is better heard in a chamber from abroad, than abroad from within the chamber.

131. As the inclosure that is round about and intire, preserveth the sound; so doth a semi-concave, though in a less degree. And therefore, if you divide a trunk, or a cane into two, and one speak at the one end, and you lay your ear at the other, it will carry the voice farther, than in the air at large. Nay further, if it be not a full semi-concave, but if you do the like upon the mast of a ship, or a long

pole, or a piece of ordnance, though one speak upon the surface of the ordnance, and not at any of the bores, the voice will be heard farther than in the air at large.

132. It would be tried, how, and with what proportion of disadvantage the voice will be carried in an horn, which is a line arched; or in a trumpet, which is a line retorted; or in some pipe that were sinuous.

133. It is certain, howsoever it cross the received opinion, that sounds may be created without air, though air be the most favourable deferent of sounds. Take a vessel of water, and knap a pair of tongs some depth within the water, and you shall hear the sound of the tongs well, and not much diminished; and yet there is no air at all present.

134. Take one vessel of silver, and another of wood, and fill each of them full of water, and then knap the tongs together, as before, about an handful from the bottom, and you shall find the sound much more resounding from the vessel of silver, than from that of wood: and yet if there be no water in the vessel, so that you knap the tongs in the air, you shall find no difference between the silver and the wooden vessel. Whereby, beside the main point of creating sound without air, you may collect two things: the one, that the sound communicateth with the bottom of the vessel; the other, that such a communication passeth far better through water than air.

135. Strike any hard bodies together in the midst of

a flame; and you shall hear the sound with little difference from the sound in the air.

136. The pneumatical part which is in all tangible bodies, and hath some affinity with the air, performeth, in some degree, the parts of the air; as when you knock upon an empty barrel, the sound is in part created by the air on the outside; and in part by the air in the inside: for the sound will be greater or lesser, as the barrel is more empty or more full; but yet the sound participateth also with the spirit in the wood through which it passeth, from the outside to the inside: and so it cometh to pass in the chiming of bells on the outside; where also the sound passeth to the inside: and a number of other like instances, whereof we shall speak more when we handle the communication of sounds.

137. It were extreme grossness to think, as we have partly touched before, that the sound in strings is made or produced between the hand and the string, or the quill and the string, or the bow and the string, for those are but "vehicula motus," passages to the creation of the sound, the sound being produced between the string and the air; and that not by any impulsion of the air from the first motion of the string; but by the return or result of the string, which was strained by the touch, to his former place: which motion of result is quick and sharp; whereas the first motion is soft and dull. So the bow tortureth the string continually, and thereby holdeth it in a continual trepidation.

Experiments in consort touching the magnitude and exility and damps of sounds.

138. Take a trunk, and let one whistle at the one end, and hold your ear at the other, and you shall find the sound strike so sharp as you can scarce endure it. The cause is, for that sound diffuseth itself in round, and so spendeth itself; but if the sound, which would scatter in open air, be made to go all into a canal, it must needs give greater force to the sound. And so you may note, that inclosures do not only preserve sound, but also increase and sharpen it.

139. A hunter's horn being greater at one end than at the other, doth increase the sound more than if the horn were all of an equal bore. The cause is, for that the air and sound being first contracted at the lesser end, and afterwards having more room to spread at the greater end, do dilate themselves; and in coming out strike more air; whereby the sound is the greater and baser. And even hunters' horns, which are sometimes made straight, and not oblique, are ever greater at the lower end. It would be tried also in pipes, being made far larger at the lower end; or being made with a belly towards the lower end, and then issuing into a straight concave again.

140. There is in St. James's fields a conduit of brick, unto which joineth a low vault; and at the end of that a round house of stone; and in the brick conduit there is a window; and in the round house a slit or rift of some little breath: if you cry out in

the rift, it will make a fearful roaring at the window. The cause is the same with the former; for that all concaves, that proceed from more narrow to more broad, do amplify the sound at the coming out.

141. Hawks' bells, that have holes in the sides give a greater ring, than if the pellet did strike upon brass in the open air. The cause is the same with the first instance of the trunk; namely, for that the sound inclosed with the sides of the bell cometh forth at the holes unspent and more strong.

142. In drums, the closeness round about, that preserveth the sound from dispersing, maketh the noise come forth at the drum-hole far more loud and strong than if you should strike upon the like skin extended in the open air. The cause is the same with the two precedent.

143. Sounds are better heard, and farther off, in an evening or in the night, than at the noon or in the day. The cause is, for that in the day, when the air is more thin, no doubt, the sound pierceth better; but when the air is more thick, as in the night, the sound spendeth and spreadeth abroad less: and so it is a degree of inclosure. As for the night, it is true also that the general silence helpeth.

144. There be two kinds of reflexions of sounds; the one at distance, which is the echo; wherein the original is heard distinctly, and the reflexion also distinctly; of which we shall speak hereafter: the other in concurrence; when the sound reflecting, the reflexion being near at hand, returneth immediately upon the original, and so iterateth it not, but ampli-

fieth it. Therefore we see, that music upon the water soundeth more; and so likewise music is better in chambers wainscotted than hanged.

145. The strings of a lute, or viol, or virginals, do give a far greater sound, by reason of the knot, and board, and concave underneath, than if there were nothing but only the flat of a board, without that hollow and knot, to let in the upper air into the lower. The cause is the communication of the upper air with the lower, and penning of both from expence or dispersing.

146. An Irish harp hath open air on both sides of the strings: and it hath the concave or belly not along the strings, but at the end of the strings. It maketh a more resounding sound than a bandora, orpharion, or citter, which have likewise wire strings. I judge the cause to be, for that open air on both sides helpeth, so that there be a concave; which is therefore best placed at the end.

147. In a virginal, when the lid is down, it maketh a more exile sound than when the lid is open. The cause is, for that all shutting in of air, where there is no competent vent, dampeth the sound: which maintaineth likewise the former instance; for the belly of the lute or viol doth pen the air somewhat.

148. There is a church at Gloucester, and, as I have heard, the like is in some other places, where if you speak against a wall softly, another shall hear your voice better a good way off, than near at hand. Inquire more particularly of the frame of that place.

I suppose there is some vault, or hollow, or isle, behind the wall, and some passage to it towards the farther end of that wall against which you speak; so as the voice of him that speaketh slideth along the wall, and then entereth at some passage, and communicateth with the air of the hollow; for it is preserved somewhat by the plain wall; but that is too weak to give a sound audible, till it hath communicated with the back air.

149. Strike upon a bow-string, and lay the horn of the bow near your ear, and it will increase the sound, and make a degree of a tone. The cause is, for that the sensory, by reason of the close holding, is percussed before the air disperseth. The like is, if you hold the horn betwixt your teeth: but that is a plain delation of the sound from the teeth to the instrument of hearing; for there is a great intercourse between those two parts; as appeareth by this, that a harsh grating tune setteth the teeth on edge. The like falleth out, if the horn of the bow be put upon the temples; but that is but the slide of the sound from thence to the ear.

150. If you take a rod of iron or brass, and hold the one end to your ear, and strike upon the other, it maketh a far greater sound than the like stroke upon the rod, made not so contiguous to the ear. By which, and by some other instances that have been partly touched, it should appear, that sounds do not only slide upon the surface of a smooth body, but do also communicate with the spirits, that are in the pores of the body.

151. I remember in Trinity College in Cambridge, there was an upper chamber, which being thought weak in the roof of it, was supported by a pillar of iron of the bigness of one's arm in the midst of the chamber; which if you had struck, it would make a little flat noise in the room where it was struck, but it would make a great bomb in the chamber beneath.

152. The sound which is made by buckets in a well, when they touch upon the water, or when they strike upon the side of the well, or when two buckets dash the one against the other, these sounds are deeper and fuller than if the like percussion were made in the open air. The cause is the penning and inclosure of the air in the concave of the well.

153. Barrels placed in a room under the floor of a chamber, make all noises in the same chamber more full and resounding.

So that there be five ways, in general, of majoration of sounds: inclosure simple; inclosure with dilatation; communication; reflexion concurrent; and approach to the sensory.

154. For exility of the voice or other sounds; it is certain that the voice doth pass through solid and hard bodies if they be not too thick: and through water, which is likewise a very close body, and such an one as letteth not in air. But then the voice, or other sound, is reduced by such passage to a great weakness or exility. If therefore you stop the holes of a hawk's bell, it will make no ring, but a flat

noise or rattle. And so doth the "aëtites" or eagle-stone, which hath a little stone within it.

155. And as for water, it is a certain trial: let a man go into a bath, and take a pail, and turn the bottom upward, and carry the mouth of it, even, down to the level of the water, and so press it down under the water some handful and an half, still keeping it even that it may not tilt on either side, and so the air get out: then let him that is in the bath dive with his head so far under water, as he may put his head into the pail, and there will come as much air bubbling forth, as will make room for his head. Then let him speak, and any that shall stand without shall hear his voice plainly; but yet made extreme sharp and exile, like the voice of puppets: but yet the articulate sounds of the words will not be confounded. Note, that it may be much more handsomely done, if the pail be put over the man's head above water, and then he cower down, and the pail be pressed down with him. Note, that a man must kneel or sit, that he may be lower than the water. A man would think that the Sicilian poet had knowledge of this experiment; for he saith, that Hercules's page, Hylas, went with a water-pot to fill it at a pleasant fountain that was near the shore, and that the nymph of the fountain fell in love with the boy, and pulled him under water, keeping him alive; and that Hercules missing his page, called him by his name aloud, that all the shore rang of it; and that Hylas from within the water answered

his master, but, that which is to the present purpose, with so small and exile a voice, as Hercules thought he had been three miles off, when the fountain, indeed, was fast by.

156. In lutes and instruments of strings, if you stop a string high, whereby it hath less scope to tremble, the sound is more treble, but yet more dead.

157. Take two saucers, and strike the edge of the one against the bottom of the other, within a pail of water; and you shall find, that as you put the saucers lower and lower, the sound groweth more flat; even while part of the saucer is above the water; but that flatness of sound is joined with a harshness of sound; which no doubt is caused by the inequality of the sound which cometh from the part of the saucer under the water, and from the part above. But when the saucer is wholly under the water the sound becometh more clear, but far more low, and as if the sound came from afar off.

158. A soft body dampeth the sound much more than a hard; as if a bell hath cloth or silk wrapped about it, it deadeth the sound more than if it were wood. And therefore in clericals the keys are lined; and in colleges they use to line the tablemen.

159. Trial was made in a recorder after these several manners. The bottom of it was set against the palm of the hand; stopped with wax round about; set against a damask cushion; thrust into sand; into ashes; into water, half an inch under the water; close to the bottom of a silver bason; and

still the tone remained: but the bottom of it was set against a woollen carpet; a lining of plush; a lock of wool, though loosely put in; against snow; and the sound of it was quite deaded, and but breath.

160. Iron hot produceth not so full a sound as when it is cold, for while it is hot, it appeareth to be more soft and less resounding. So likewise warm water, when it falleth, maketh not so full a sound as cold, and I conceive it is softer, and nearer the nature of oil, for it is more slippery, as may be perceived in that it scowreth better.

161. Let there be a recorder made with two fipples, at each end one: the trunk of it of the length of two recorders, and the holes answerable towards each end, and let two play the same lesson upon it at an unison; and let it be noted whether the sound be confounded, or amplified, or dulled. So likewise let a cross be made of two trunks, throughout, hollow, and let two speak, or sing, the one longways, the other traverse: and let two hear at the opposite ends, and note whether the sound be confounded, amplified, or dulled. Which two instances will also give light to the mixture of sounds, whereof we shall speak hereafter.

162. A bellows blown in at the hole of a drum, and the drum then strucken, maketh the sound a little flatter, but no other apparent alteration. The cause is manifest: partly for that it hindereth the issue of the sound, and partly for that it maketh the air, being blown together, less moveable.

Experiments in consort touching the loudness or softness of sounds, and their carriage at longer or shorter distance.

163. The loudness and softness of sounds is a thing distinct from the magnitude and exility of sounds; for a base string, though softly strucken, giveth the greater sound; but a treble string, if hard strucken, will be heard much farther off. And the cause is, for that the base string striketh more air, and the treble less air, but with a sharper percussion.

164. It is therefore the strength of the percussion, that is a principal cause of the loudness or softness of sounds; as in knocking harder or softer, winding of a horn stronger or weaker, ringing of a hand-bell harder or softer, &c. And the strength of this percussion consisteth as much or more in the hardness of the body percussed, as in the force of the body percussing: for if you strike against a cloth, it will give a less sound, if against wood, a greater, if against metal, yet a greater, and in metals, if you strike against gold, which is the more pliant, it giveth the flatter sound: if against silver or brass, the more ringing sound. As for air, where it is strongly pent, it matcheth a hard body. And therefore we see in discharging of a piece, what a great noise it maketh. We see also, that the charge with bullet, or with paper wet and hard stopped, or with powder alone, rammed in hard, maketh no great difference in the loudness of the report.

165. The sharpness or quickness of the percussion, is a great cause of the loudness, as well as the strength; as in a whip or wand, if you strike the air with it; the sharper and quicker you strike it, the louder sound it giveth. And in playing upon the lute or virginals, the quick stroke or touch is a great life to the sound. The cause is, for that the quick striking cutteth the air speedily; whereas the soft striking doth rather beat than cut.

Experiments in consort touching the communication of sounds.

The communication of sounds, as in bellies of lutes, empty vessels, &c. hath been touched "obiter" in the majoration of sounds; but it is fit also to make a title of it apart.

166. The experiment for greatest demonstration of communication of sounds, is the chiming of bells; where if you strike with a hammer upon the upper part, and then upon the midst, and then upon the lower, you shall find the sound to be more treble and more base, according unto the concave on the inside, though the percussion be only on the outside.

167. When the sound is created between the blast of the mouth and the air of the pipe, it hath nevertheless some communication with the matter of the sides of the pipe, and the spirits in them contained; for in a pipe, or trumpet, of wood, and brass, the sound will be diverse; so if the pipe be covered with cloth or silk, it will give a diverse sound from that it would do of itself; so if the pipe be a

little wet on the inside, it will make a differing sound from the same pipe dry.

168. That sound made within water doth communicate better with a hard body through water, than made in air it doth with air, "vide experimentum 134."

Experiments in consort touching equality and inequality of sounds.

We have spoken before, in the inquisition touching music, of musical sounds, whereunto there may be a concord or discord in two parts; which sounds we call tones; and likewise of immusical sounds; and have given the cause, that the tone proceedeth of equality, and the other of inequality. And we have also expressed there, what are the equal bodies that give tones, and what are the unequal that give none. But now we shall speak of such inequality of sounds, as proceedeth not from the nature of the bodies themselves, but as accidental; either from the roughness or obliquity of the passage, or from the doubling of the percutient, or from the trepidation of the motion.

169. A bell, if it have a rift in it, whereby the sound hath not a clear passage, giveth a hoarse and jarring sound: so the voice of man, when by cold taken the weasond groweth rugged, and, as we call it, furred, becometh hoarse. And in these two instances the sounds are ingrate, because they are merely unequal: but if they be unequal in equality, then the sound is grateful but purling.

170. All instruments that have either returns, as trumpets; or flexions, as cornets; or are drawn up, and put from, as sackbuts; have a purling sound: but the recorder, or flute, that have none of these inequalities, give a clear sound. Nevertheless, the recorder itself, or pipe, moistened a little in the inside, soundeth more solemnly, and with a little purling or hissing. Again, a wreathed string, such as are in the base strings of bandoras, giveth also a purling sound.

171. But a lute-string, if it be merely unequal in its parts, giveth a harsh and untunable sound; which strings we call false, being bigger in one place than in another; and therefore wire strings are never false. We see also, that when we try a false lute-string, we use to extend it hard between the fingers, and to fillip it; and if it giveth a double species, it is true; but if it giveth a treble, or more, it is false.

172. Waters, in the noise they make as they run, represent to the ear a trembling noise; and in regals, where they have a pipe they call the nightingale-pipe, which containeth water, the sound hath a continual trembling: and children have also little things they call cocks, which have water in them; and when they blow or whistle in them, they yield a trembling noise; which trembling of water hath an affinity with the letter *L*. All which inequalities of trepidation are rather pleasant than otherwise.

173. All base notes, or very treble notes, give an asper sound; for that the base striketh more air, than it can well strike equally: and the treble

cutteth the air so sharp, as it returneth too swift to make the sound equal: and therefore a mean or tenor is the sweetest part.

174. We know nothing that can at pleasure make a musical or immusical sound by voluntary motion, but the voice of man and birds. The cause is, no doubt, in the weasond or windpipe, which we call "aspera arteria," which being well extended, gathereth equality; as a bladder that is wrinkled, if it be extended, becometh smooth. The extension is always more in tones than in speech: therefore the inward voice or whisper can never give a tone. And in singing, there is, manifestly, a greater working and labour of the throat, than in speaking; as appeareth in the thrusting out or drawing in of the chin, when we sing.

175. The humming of bees is an unequal buzzing, and is conceived by some of the ancients not to come forth at their mouth, but to be an inward sound; but, it may be, it is neither; but from the motion of their wings: for it is not heard but when they stir.

176. All metals quenched in water give a sibilation or hissing sound, which hath an affinity with the letter *Z*, notwithstanding the sound be created between the water or vapour, and the air. Seething also, if there be but small store of water in a vessel giveth a hissing sound; but boiling in a full vessel giveth a bubbling sound, drawing somewhat near to the cocks used by children.

177. Trial would be made, whether the inequa-

lity or interchange of the medium will not produce an inequality of sound; as if three bells were made one within another, and air betwixt each; and then the uttermost bell were chimed with a hammer, how the sound would differ from a simple bell. So likewise take a plate of brass, and a plank of wood, and join them close together, and knock upon one of them, and see if they do not give an unequal sound. So make two or three partitions of wood in a hogshead, with holes or knots in them; and mark the difference of their sound from the sound of an hogshead without such partitions.

Experiments in consort touching the more treble, and the more base tones, or musical sounds.

178. It is evident, that the percussion of the greater quantity of air causeth the baser sound; and the less quantity the more treble sound. The percussion of the greater quantity of air is produced by the greatness of the body percussing; by the latitude of the concave by which the sound passeth; and by the longitude of the same concave. Therefore we see that a base string is greater than a treble; a base pipe hath a greater bore than a treble; and in pipes, and the like, the lower the note-holes be, and the further off from the mouth of the pipe, the more base sound they yield; and the nearer the mouth, the more treble. Nay more, if you strike an entire body, as an andiron of brass, at the top, it maketh a more treble sound; and at the bottom a baser.

179. It is also evident, that the sharper or quicker percussion of air causeth the more treble sound; and the slower or heavier, the more base sound. So we see in strings; the more they are wound up and strained, and thereby give a more quick start-back, the more treble is the sound; and the slacker they are, or less wound up, the baser is the sound. And therefore a bigger string more strained, and a lesser string less strained, may fall into the same tone.

180. Children, women, eunuchs, have more small and shrill voices than men. The reason is, not for that men have greater heat, which may make the voice stronger, for the strength of a voice or sound doth make a difference in the loudness or softness, but not in the tone, but from the dilatation of the organ; which, it is true, is likewise caused by heat. But the cause of changing the voice at the years of puberty, is more obscure. It seemeth to be, for that when much of the moisture of the body, which did before irrigate the parts, is drawn down to the spermatical vessels, it leaveth the body more hot than it was; whence cometh the dilatation of the pipes: for we see plainly all effects of heats do then come on; as pilosity, more roughness of the skin, hardness of the flesh, &c.

181. The industry of the musician hath produced two other means of straining or intension of strings, besides their winding up. The one is the stopping of the string with the finger; as in the necks of lutes, viols, &c. The other is the shortness

of the string, as in harps, virginals, &c. Both these have one and the same reason; for they cause the string to give a quicker start.

182. In the straining of a string, the further it is strained, the less superstraining goeth to a note; for it requireth good winding of a string before it will make any note at all: and in the stops of lutes, &c. the higher they go, the less distance is between the frets.

183. If you fill a drinking-glass with water, especially one sharp below, and wide above, and fillip upon the brim or outside; and after empty part of the water, and so more and more, and still try the tone by filliping; you shall find the tone fall and be more base, as the glass is more empty.

Experiments in consort touching the proportion of treble and base tones.

The just and measured proportion of the air percussed, towards the baseness or trebleness of tones, is one of the greatest secrets in the contemplation of sounds. For it discovereth the true coincidence of tones into diapasons; which is the return of the same sound. And so of the concords and discords between the unison and diapason, which we have touched before in the experiments of music; but think fit to resume it here as a principal part of our inquiry touching the nature of sounds. It may be found out in the proportion of the winding of strings; in the proportion of the distance of frets; and in the proportion of the concave of pipes, &c. but most commodiously in the last of these.

184. Try therefore the winding of a string once about, as soon as it is brought to that extension as will give a tone; and then of twice about, and thrice about, &c. and mark the scale or difference of the rise of the tone: whereby you shall discover, in one, two effects; both the proportion of the sound towards the dimension of the winding; and the proportion likewise of the sound towards the string, as it is more or less strained. But note that to measure this, the way will be, to take the length in a right line of the string, upon any winding about of the peg.

185. As for the stops, you are to take the number of frets; and principally the length of the line, from the first stop of the string, unto such a stop as shall produce a diapason to the former stop upon the same string.

186. But it will best, as it is said, appear in the bores of wind instruments: and therefore cause some half dozen pipes to be made, in length and all things else alike, with a single, double, and so on to a sextuple bore; and so mark what fall of tone every one giveth. But still in these three last instances, you must diligently observe, what length of string, or distance of stop, or concave of air, maketh what rise of sound. As in the last of these, which, as we said, is that which giveth the aptest demonstration, you must set down what increase of concave goeth to the making of a note higher; and what of two notes; and what of three notes; and so up to the diapason: for then the great secret of numbers and proportions will appear. It is not unlike that those

that make recorders, &c. know this already: for that they make them in sets: and likewise bell-founders, in fitting the tune of their bells. So that inquiry may save trial. Surely it hath been observed by one of the ancients, that an empty barrel knocked upon with the finger, giveth a diapason to the sound of the like barrel full; but how that should be I do not well understand; for that the knocking of a barrel full or empty, doth scarce give any tone.

187. There is required some sensible difference in the proportion of creating a note, towards the sound itself, which is the passive: and that it be not too near, but at a distance. For in a recorder, the three uppermost holes yield one tone; which is a note lower than the tone of the first three. And the like, no doubt, is required in the winding or stopping of strings.

Experiments in consort touching exterior and interior sounds.

There is another difference of sounds, which we will call exterior and interior. It is not soft nor loud: nor it is not base nor treble: nor it is not musical nor immusical: though it be true, that there can be no tone in an interior sound; but on the other side, in an exterior sound there may be both musical and immusical. We shall therefore enumerate them, rather than precisely distinguish them; though, to make some adumbration of what we mean, the interior is rather an impulsion or contusion of the air, than an elision or section of the same: so as

the percussion of the one towards the other differeth as a blow differeth from a cut.

188. In speech of man, the whispering, which they call "susurrus" in Latin, whether it be louder or softer, is an interior sound; but the speaking out is an exterior sound; and therefore you can never make a tone, nor sing in whispering; but in speech you may: so breathing, or blowing by the mouth, bellows, or wind, though loud, is an interior sound; but the blowing through a pipe or concave, though soft, is an exterior. So likewise the greatest winds, if they have no coarctation, or blow not hollow, give an interior sound; the whistling or hollow wind yieldeth a singing, or exterior sound; the former being pent by some other body; the latter being pent in by its own density: and therefore we see, that when the wind bloweth hollow, it is a sign of rain. The flame, as it moveth within in itself or is blown by a bellows, giveth a murmur or interior sound.

189. There is no hard body, but struck against another hard body, will yield an exterior sound greater or lesser: insomuch as if the percussion be over-soft, it may induce a nullity of sound; but never an interior sound; as when one treadeth so softly that he is not heard.

190. Where the air is the percutient, pent or not pent, against a hard body, it never giveth an exterior sound; as if you blow strongly with a bellows against a wall.

191. Sounds, both exterior and interior, may be

made as well by suction as by emission of the breath: as in whistling or breathing.

Experiments in consort touching articulation of sounds.

192. It is evident, and it is one of the strangest secrets in sounds, that the whole sound is not in the whole air only; but the whole sound is also in every small part of the air. So that all the curious diversity of articulate sounds, of the voice of man or birds, will enter at a small cranny inconfused.

193. The unequal agitation of the winds and the like, though they be material to the carriage of the sounds farther or less way: yet they do not confound the articulation of them at all, within that distance that they can be heard; though it may be, they make them to be heard less way than in a still; as hath been partly touched.

194. Over great distance confoundeth the articulation of sounds; as we see, that you may hear the sound of a preacher's voice, or the like, when you cannot distinguish what he saith. And one articulate sound will confound another, as when many speak at once.

195. In the experiment of speaking under water, when the voice is reduced to such an extreme exility, yet the articulate sounds, which are the words, are not confounded, as hath been said.

196. I conceive, that an extreme small or an extreme great sound cannot be articulate; but that the articulation requireth a mediocrity of sound: for that the extreme small sound confoundeth the articulation by contracting; and the great sound by

dispersing: and although, as was formerly said, a sound articulate, already created, will be contracted into a small cranny; yet the first articulation requireth more dimension.

197. It hath been observed, that in a room, or in a chapel, vaulted below and vaulted likewise in the roof, a preacher cannot be heard so well, as in the like places, not so vaulted. The cause is, for that the subsequent words come on before the precedent words vanish: and therefore the articulate sounds are more confused, though the gross of the sound be greater.

198. The motions of the tongue, lips, throat, palate, &c. which go to the making of the several alphabetical letters, are worthy inquiry, and pertinent to the present inquisition of sounds: but because they are subtle, and long to describe, we will refer them over, and place them amongst the experiments of speech. The Hebrews have been diligent in it, and have assigned which letters are labial, which dental, which guttural, &c. As for the Latins and Grecians, they have distinguished between semivowels and mutes; and in mutes between "mutæ "tenues, mediæ," and "aspiratæ;" not amiss, but yet not diligently enough. For the special strokes and motions that create those sounds, they have little inquired: as, that the letters *B, P, F, M,* are not expressed, but with the contracting or shutting of the mouth; that the letters *N* and *B,* cannot be pronounced but that the letter *N* will turn into *M;* as "hecatonba" will be "hecatomba." That *M* and *T* cannot be pronounced together, but *P* will come

between; as "emtus" is pronounced "emptus;" and a number of the like. So that if you inquire to the full, you will find, that to the making of the whole alphabet there will be fewer simple motions required than there are letters.

199. The lungs are the most spungy part of the body; and therefore ablest to contract and dilate itself; and where it contracteth itself, it expelleth the air; which through the artery, throat, and mouth, maketh the voice: but yet articulation is not made but with the help of the tongue, palate, and the rest of those they call instruments of voice.

200. There is found a similitude between the sound that is made by inanimate bodies or by animate bodies, that have no voice articulate, and divers letters of articulate voices: and commonly men have given such names to those sounds, as do allude unto the articulate letters; as trembling of water hath resemblance with the letter *L*; quenching of hot metals with the letter *Z*; snarling of dogs with the letter *R*; the noise of screech-owls with the letter *Sh*; voice of cats with the diphthong *Eu*; voice of cuckows with the diphthong *Ou*; sounds of strings with the letter *Ng*; so that if a man, for curiosity or strangeness sake, would make a puppet or other dead body to pronounce a word, let him consider, on the one part, the motion of the instruments of voice; and on the other part, the like sounds made in inanimate bodies; and what conformity there is that causeth the similitude of sounds; and by that he may minister light to that effect.

NATURAL HISTORY.

CENTURY III.

Experiments in consort touching the motion of sounds, in what lines they are circular, oblique, straight, upwards, downwards, forwards, backwards.

201. All sounds whatsoever move round; that is to say, on all sides; upwards, downwards, forwards, and backwards. This appeareth in all instances.

202. Sounds do not require to be conveyed to the sense in a right line, as visibles do, but may be arched; though it be true, they move strongest in a right line; which nevertheless is not caused by the rightness of the line, but by the shortness of the distance; "linea recta brevissima." And therefore we see if a wall be between, and you speak on the one side, you hear it on the other; which is not because the sound passeth through the wall, but archeth over the wall.

203. If the sound be stopped and repercussed, it cometh about on the other side in an oblique line. So, if in a coach one side of the boot be down, and the other up, and a beggar beg on the close side;

you will think that he were on the open side. So likewise, if a bell or clock be, for example, on the north side of a chamber, and the window of that chamber be upon the south; he that is in the chamber will think the sound came from the south.

204. Sounds, though they spread round, so that there is an orb or spherical area of the sound, yet they move strongest, and go farthest in the forelines, from the first local impulsion of the air. And therefore in preaching, you shall hear the preacher's voice better before the pulpit, than behind it, or on the sides, though it stand open. So a harquebuss, or ordnance, will be farther heard forwards from the mouth of the piece, than backwards, or on the sides.

205. It may be doubted, that sounds do move better downwards than upwards. Pulpits are placed high above the people. And when the ancient generals spake to their armies, they had ever a mount of turf cast up, whereupon they stood; but this may be imputed to the stops and obstacles which the voice meeteth with, when one speaketh upon the level. But there seemeth to be more in it; for it may be that spiritual species, both of things visible and sounds, do move better downwards than upwards. It is a strange thing, that to men standing below on the ground, those that be on the top of Paul's seem much less than they are, and cannot be known; but to men above, those below seem nothing so much lessened, and may be known: yet it is true, that all things to them above seem also somewhat contracted, and better collected into figure: as

knots in gardens shew best from an upper window or terras.

206. But to make an exact trial of it, let a man stand in a chamber not much above the ground, and speak out at the window, through a trunk, to one standing on the ground, as softly as he can, the other laying his ear close to the trunk; then "via "versa," let the other speak below, keeping the same proportion of softness; and let him in the chamber lay his ear to the trunk: and this may be the aptest means to make a judgment, whether sounds descend or ascend better.

Experiments in consort touching the lasting and perishing of sounds; and touching the time they require to their generation or delation.

207. After that sound is created, which is in a moment, we find it continueth some small time, melting by little and little. In this there is a wonderful error amongst men, who take this to be a continuance of the first sound; whereas, in truth, it is a renovation, and not a continuance; for the body percussed hath, by reason of the percussion, a trepidation wrought in the minute parts, and so reneweth the percussion of the air. This appeareth manifestly, because that the melting sound of a bell, or of a string strucken, which is thought to be a continuance, ceaseth as soon as the bell or string are touched. As in a virginal, as soon as ever the jack falleth, and toucheth the string, the sound ceaseth; and in a bell, after you have chimed upon it, if you

touch the bell the sound ceaseth. And in this you must distinguish that there are two trepidations: the one manifest and local; as of the bell when it is pensile: the other secret, of the minute parts; such as is described in the ninth instance. But it is true, that the local helpeth the secret greatly. We see likewise that in pipes, and other wind-instruments, the sound lasteth no longer than the breath bloweth. It is true, that in organs there is a confused murmur for a while after you have played; but that is but while the bellows are in falling.

208. It is certain, that in the noise of great ordnance, where many are shot off together, the sound will be carried, at the least, twenty miles upon the land, and much farther upon the water. But then it will come to the ear, not in the instant of the shooting off, but it will come an hour or more later. This must needs be a continuance of the first sound; for there is no trepidation which should renew it. And the touching of the ordnance would not extinguish the sound the sooner: so that in great sounds the continuance is more than momentary.

209. To try exactly the time wherein sound is delated, let a man stand in a steeple, and have with him a taper; and let some veil be put before the taper; and let another man stand in the field a mile off. Then let him in the steeple strike the bell; and in the same instant withdraw the veil; and so let him in the field tell by his pulse what distance of time there is between the light seen, and the sound heard: for it is certain that the delation of light is

in an instant. This may be tried in far greater distances, allowing greater lights and sounds.

210. It is generally known and observed that light, and the object of sight move swifter than sound: for we see the flash of a piece is seen sooner than the noise is heard. And in hewing wood, if one be some distance off, he shall see the arm lifted up for a second stroke, before he hear the noise of the first. And the greater the distance, the greater is the prevention: as we see in thunder which is far off, where the lightning precedeth the crack a good space.

211. Colours when they represent themselves to the eye, fade not, nor melt not by degrees, but appear still in the same strength; but sounds melt and vanish by little and little. The cause is, for that colours participate nothing with the motion of the air, but sounds do. And it is a plain argument, that sound participateth of some local motion of the air, as a cause "sine qua non," in that it perisheth so suddenly; for in every section or impulsion of the air, the air doth suddenly restore and reunite itself; which the water also doth, but nothing so swiftly.

Experiments in consort touching the passage and interceptions of sounds.

In the trials of the passage, or not passage of sounds, you must take heed you mistake not the passing by the sides of a body for the passing through a body; and therefore you must make the intercepting body very close; for sound will pass through a small chink.

212. Where sound passeth through a hard or

close body, as through water; through a wall; through metal, as in hawks' bells stopped, &c. the hard or close body must be but thin and small; for else it deadeth and extinguisheth the sound utterly. And therefore in the experiment of speaking in air under water, the voice must not be very deep within the water: for then the sound pierceth not. So if you speak on the farther side of a close wall, if the wall be very thick you shall not be heard; and if there were an hogshead empty, whereof the sides were some two foot thick, and the bunghole stopped; I conceive the resounding sound, by the communication of the outward air with the air within, would be little or none: but only you shall hear the noise of the outward knock, as if the vessel were full.

213. It is certain, that in the passage of sounds through hard bodies the spirit or pneumatical part of the body itself doth co-operate; but much better when the sides of that hard body are struck, than when the percussion is only within, without touch of the sides. Take therefore a hawk's bell, the holes stopped up, and hang it by a thread within a bottle glass, and stop the mouth of the glass very close with wax; and then shake the glass, and see whether the bell give any sound at all, or how weak: but note, that you must instead of the thread take a wire; or else let the glass have a great belly; lest when you shake the bell, it dash upon the sides of the glass.

214. It is plain, that a very long and downright arch for the sound to pass, will extinguish the sound

quite; so that that sound, which would be heard over a wall, will not be heard over a church; nor that sound, which will be heard if you stand some distance from the wall, will be heard if you stand close under the wall.

215. Soft and foraminous bodies, in the first creation of the sound, will dead it; for the striking against cloth or furr will make little sound; as hath been said: but in the passage of the sound, they will admit it better than harder bodies; as we see, that curtains and hangings will not stay the sound much; but glass windows, if they be very close, will check a sound more than the like thickness of cloth. We see also in the rumbling of the belly, how easily the sound passeth through the guts and skin.

216. It is worthy the inquiry, whether great sounds, as of ordnance or bells, become not more weak and exile when they pass through small crannies. For the subtilties of articulate sounds, it may be, may pass through small crannies not confused, but the magnitude of the sound, perhaps, not so well.

Experiments in consort touching the medium of sounds.

217. The mediums of sounds are air, soft and porous bodies, also water. And hard bodies refuse not altogether to be mediums of sounds. But all of them are dull and unapt deferents, except the air.

218. In air, the thinner or drier air carrieth not the sound so well as the more dense; as appeareth in night sounds and evening sounds, and sounds in moist weather and southern winds. The reason is

already mentioned in the title of majoration of sounds; being for that thin air is better pierced; but thick air preserveth the sound better from waste: let further trial be made by hollowing in mists and gentle showers; for it may be, that will somewhat dead the sound.

219. How far forth flame may be a medium of sounds, especially of such sounds as are created by air, and not betwixt hard bodies, let it be tried in speaking where a bonfire is between; but then you must allow for some disturbance the noise that the flame itself maketh.

220. Whether any other liquors, being made mediums, cause a diversity of sound from water, it may be tried: as by the knapping of the tongs; or striking of the bottom of a vessel, filled either with milk or with oil; which though they be more light, yet are they more unequal bodies than air.

Of the natures of the mediums we have now spoken; as for the disposition of the said mediums, it doth consist in the penning, or not penning of the air; of which we have spoken before in the title of delation of sounds: it consisteth also in the figure of the concave through which it passeth; of which we will speak next.

Experiments in consort, what the figures of the pipes, or concaves, or the bodies deferent, conduce to the sounds.

How the figures of pipes, or concaves, through which sounds pass, or of other bodies deferent, con-

duce to the variety and alteration of the sounds; either in respect of the greater quantity, or less quantity of air, which the concaves receive, or in respect of the carrying of sounds longer and shorter way; or in respect of many other circumstances; they have been touched, as falling into other titles. But those figures which we are now to speak of, we intend to be, as they concern the lines through which the sound passeth; as straight, crooked, angular, circular, &c.

221. The figure of a bell partaketh of the pyramis, but yet coming off and dilating more suddenly. The figure of a hunter's horn and cornet is oblique; yet they have likewise straight horns; which, if they be of the same bore with the oblique, differ little in sound, save that the straight require somewhat a stronger blast. The figures of recorders, and flutes, and pipes, are straight; but the recorder hath a less bore and a greater, above and below. The trumpet hath the figure of the letter *S:* which maketh that purling sound, &c. Generally the straight line hath the cleanest and roundest sound, and the crooked, the more hoarse and jarring.

222. Of a sinuous pipe that may have some four flexions, trial would be made. Likewise of a pipe made like across, open in the midst. And so likewise of an angular pipe; and see what will be the effects of these several sounds. And so again of a circular pipe; as if you take a pipe perfect round, and make a hole whereinto you shall blow, and, another hole not far from that; but with a traverse

or stop between them; so that your breath may go the round of the circle, and come forth at the second hole. You may try likewise percussions of solid bodies of several figures; as globes, flats, cubes, crosses, triangles, &c. and their combinations, as flat against flat, and convex against convex, and convex against flat, &c. and mark well the diversities of the sounds. Try also the difference in sound of several crassitudes of hard bodies percussed; and take knowledge of the diversities of the sounds. I myself have tried, that a bell of gold yieldeth an excellent sound, not inferior to that of silver or brass, but rather better: yet we see that a piece of money of gold soundeth far more flat than a piece of money of silver.

223. The harp hath the concave not along the strings, but across the strings; and no instrument hath the sound so melting and prolonged, as the Irish harp. So as I suppose, that if a virginal were made with a double concave, the one all the length, as the virginal hath, the other at the end of the strings, as the harp hath; it must needs make the sound perfecter, and not so shallow and jarring. You may try it without any sound-board along, but only harp-wise at one end of the strings; or lastly, with a double concave, at each end of the strings one.

Experiments in consort touching the mixture of sounds.

224. There is an apparent diversity between the species visible and audible in this, that the visible doth not mingle in the medium, but the audible

doth. For if we look abroad, we see heaven, a number of stars, trees, hills, men, beasts, at once. And the species of the one doth not confound the other. But if so many sounds came from several parts, one of them would utterly confound the other. So we see, that voices or consorts of music do make an harmony by mixture, which colours do not. It is true nevertheless that a great light drowneth a smaller, that it cannot be seen; as the sun that of a glow-worm; as well as a great sound drowneth a lesser. And I suppose likewise, that if there were two lanthorns of glass, the one a crimson, and the other an azure, and a candle within either of them, those coloured lights would mingle, and cast upon a white paper a purple colour. And even in colours, they yield a faint and weak mixture: for white walls make rooms more lightsome than black, &c. but the cause of the confusion in sounds, and the inconfusion in species visible, is, for that the sight worketh in right lines, and maketh several cones; and so there can be no coincidence in the eye or visual point: but sounds, that move in oblique and arcuate lines, must needs encounter and disturb the one the other.

225. The sweetest and best harmony is, when every part or instrument is not heard by itself, but a conflation of them all; which requireth to stand some distance off, even as it is in the mixture of perfumes; or the taking of the smells of several flowers in the air.

226. The disposition of the air in other qualities,

except it be joined with sound, hath no great operation upon sounds: for whether the air be lightsome or dark, hot or cold, quiet or stirring, except it be with noise, sweet smelling, or stinking, or the like; it importeth not much; some petty alteration or difference it may make.

227. But sounds do disturb and alter the one the other: sometimes the one drowning the other, and making it not heard; sometimes the one jarring and discording with the other, and making a confusion; sometimes the one mingling and compounding with the other, and making an harmony.

228. Two voices of like loudness will not be heard twice as far as one of them alone: and two candles of like light, will not make things seen twice as far off as one. The cause is profound; but it seemeth that the impressions from the objects of the senses do mingle respectively, every one with his kind: but not in proportion, as is before demonstrated: and the reason may be, because the first impression, which is from privative to active, as from silence to noise, or from darkness to light, is a greater degree than from less noise to more noise, or from less light to more light. And the reason of that again may be, for that the air, after it hath received a charge, doth not receive a surcharge, or greater charge, with like appetite as it doth the first charge. As for the increase of virtue, generally, what proportion it beareth to the increase of the matter, it is a large field, and to be handled by itself.

Experiments in consort touching melioration of sounds.

229. All reflections concurrent do make sounds greater; but if the body that createth either the original sound, or the reflection, be clean and smooth, it maketh them sweeter. Trial may be made of a lute or viol, with the belly of polished brass instead of wood. We see that even in the open air, the wire-string is sweeter than the string of guts. And we see that for reflexion water excelleth; as in music near the water, or in echoes.

230. It hath been tried, that a pipe a little moistened on the inside, but yet so as there be no drops left, maketh a more solemn sound, than if the pipe were dry: but yet with a sweet degree of sibilation or purling; as we touched it before in the title of equality. The cause is, for that all things porous being superficially wet, and, as it were, between dry and wet, became a little more even and smooth; but the purling, which must needs proceed of inequality, I take to be bred between the smoothness of the inward surface of the pipe, which is wet, and the rest of the wood of the pipe unto which the wet cometh not, but it remaineth dry.

231. In frosty weather music within doors soundeth better. Which may be by reason not of the disposition of the air, but of the wood or string of the instrument, which is made more crisp, and so more porous and hollow: and we see that old lutes sound better than new for the same reason. And so do lute-strings that have been kept long.

232. Sound is likewise meliorated by the mingling of open air with pent air; therefore trial may be made of a lute or viol with a double belly, making another belly with a knot over the strings; yet so, as there be room enough for the strings, and room enough to play below that belly. Trial may be made also of an Irish harp, with a concave on both sides, whereas it useth to have it but on one side. The doubt may be, lest it should make too much resounding, whereby one note would overtake another.

233. If you sing into the hole of a drum, it maketh the singing more sweet. And so I conceive it would, if it were a song in parts sung into several drums; and for handsomeness and strangeness sake, it would not be amiss to have a curtain between the place where the drums are and the hearers.

234. When a sound is created in a wind-instrument between the breath and the air, yet if the sound be communicated with a more equal body of the pipe, it meliorateth the sound. For, no doubt, there would be a differing sound in a trumpet or pipe of wood: and again in a trumpet or pipe of brass. It were good to try recorders and hunters' horns of brass, what the sound would be.

235. Sounds are meliorated by the intension of the sense, where the common sense is collected most to the particular sense of hearing, and the sight suspended: and therefore sounds are sweeter, as well as greater, in the night than in the day; and I suppose they are sweeter to blind men than to others: and it is manifest, that between sleeping

and waking, when all the senses are bound and suspended, music is far sweeter than when one is fully waking.

Experiments in consort touching the imitation of sounds.

236. It is a thing strange in nature when it is attentively considered, how children, and some birds, learn to imitate speech. They take no mark at all of the motion of the mouth of him that speaketh, for birds are as well taught in the dark as by light. The sounds of speech are very curious and exquisite: so one would think it were a lesson hard to learn. It is true that it is done with time, and by little and little, and with many essays and proffers: but all this dischargeth not the wonder. It would make a man think, though this which we shall say may seem exceeding strange, that there is some transmission of spirits; and that the spirits of the teacher put in motion, should work with the spirits of the learner a pre-disposition to offer to imitate; and so to perfect the imitation by degrees. But touching operations by transmissions of spirits, which is one of the highest secrets in nature, we shall speak in due place, chiefly when we come to inquire of imagination. But as for imitation, it is certain that there is in men and other creatures a pre-disposition to imitate. We see how ready apes and monkeys are to imitate all motions of man; and in the catching of dottrels, we see how the foolish bird playeth the ape in gestures: and no man, in effect, doth accompany with others, but he learneth, ere he

is aware, some gesture, or voice, or fashion of the other.

237. In imitation of sounds, that man should be the teacher is no part of the matter; for birds will learn one of another; and there is no reward by feeding, or the like, given them for the imitation; and besides, you shall have parrots that will not only imitate voices, but laughing, knocking, squeaking of a door upon the hinges, or of a cart-wheel; and, in effect, any other noise they hear.

238. No beast can imitate the speech of man but birds only: for the ape itself, that is so ready to imitate otherwise, attaineth not any degree of imitation of speech. It is true, that I have known a dog, that if one howled in his ear, he would fall a howling a great while. What should be the aptness of birds in comparison of beasts, to imitate the speech of man, may be further inquired. We see that beasts have those parts which they count the instruments of speech, as lips, teeth, &c. liker unto man than birds. As for the neck, by which the throat passeth, we see many beasts have it for the length as much as birds. What better gorge or artery birds have, may be farther inquired. The birds that are known to be speakers, are parrots, pies, jays, daws, and ravens. Of which parrots have an adunque bill, but the rest not.

239. But I conceive. that the aptness of birds is not so much in the conformity of the organs of speech, as in their attention. For speech must come by hearing and learning; and birds give more heed, and mark sounds more than beasts; because

naturally they are more delighted with them, and practise them more, as appeareth in their singing. We see also that those that teach birds to sing, do keep them waking to increase their attention. We see also that cock birds amongst singing birds are ever the better singers; which may be because they are more lively and listen more.

240. Labour and intention to imitate voices, doth conduce much to imitation: and therefore we see that there be certain "pantomimi," that will represent the voices of players of interludes so to life, as if you see them not you would think they were those players themselves; and so the voices of other men that they hear.

241. There have been some that could counterfeit the distance of voices, which is a secondary object of hearing, in such sort, as when they stand fast by you, you would think the speech came from afar off, in a fearful manner. How this is done may be further inquired. But I see no great use of it but for imposture, in counterfeiting ghosts or spirits.

Experiments in consort touching the reflexion of sounds.

There be three kinds of reflexions of sounds; a reflexion concurrent, a reflexion iterant, which we call echo; and a super-reflexion, or an echo of an echo; whereof the first hath been handled in the title of magnitude of sounds: the latter two we will now speak of.

242. The reflexion of species visible by mirrors you may command; because passing in right lines

they may be guided to any point: but the reflexion of sounds is hard to master; because the sound filling great spaces in arched lines, cannot be so guided: and therefore we see there hath not been practised any means to make artificial echoes. And no echo already known returneth in a very narrow room.

243. The natural echoes are made upon walls, woods, rocks, hills, and banks; as for waters, being near, they make a concurrent echo; but being farther off, as upon a large river, they make an iterant echo: for there is no difference between the concurrent echo and the iterant, but the quickness or slowness of the return. But there is no doubt but water doth help the delation of echo; as well as it helpeth the delation of original sounds.

244. It is certain, as hath been formerly touched, that if you speak through a trunk stopped at the farther end, you shall find a blast return upon your mouth, but no sound at all. The cause is, for that the closeness which preserveth the original, is not able to preserve the reflected sound: besides that echoes are seldom created but by loud sounds. And therefore there is less hope of artificial echoes in air pent in a narrow concave. Nevertheless it hath been tried, that one leaning over a well of twenty-five fathom deep, and speaking, though but softly, yet not so soft as a whisper, the water returned a good audible echo. It would be tried, whether speaking in caves, where there is no issue save where you speak, will not yield echoes as wells do.

245. The echo cometh as the original sound doth,

in a round orb of air: it were good to try the creating of the echo where the body repercussing maketh an angle: as against the return of a wall, &c. Also we see that in mirrors there is the like angle of incidence, from the object to the glass, and from the glass to the eye. And if you strike a ball sidelong, not full upon the surface, the rebound will be as much the contrary way: whether there be any such resilience in echoes, that is, whether a man shall hear better if he stand aside the body repercussing, than if he stand where he speaketh, or any where in a right line between, may be tried. Trial likewise would be made, by standing nearer the place of repercussing than he that speaketh; and again by standing farther off than he that speaketh; and so knowledge would be taken, whether echoes, as well as original sounds, be not strongest near hand.

246. There be many places where you shall hear a number of echoes one after another: and it is when there is variety of hills or woods, some nearer, some farther off: so that the return from the farther, being last created, will be likewise last heard.

247. As the voice goeth round, as well towards the back, as towards the front of him that speaketh; so likewise doth the echo: for you have many back echoes to the place where you stand.

248. To make an echo that will report three, or four, or five words distinctly, it is requisite that the body repercussing be a good distance off: for if it be near, and yet not so near as to make a concurrent

echo, it choppeth with you upon the sudden. It is requisite likewise that the air be not much pent: for air at a great distance pent, worketh the same effect with air at large in a small distance. And therefore in the trial of speaking in the well, though the well was deep, the voice came back suddenly, and would bear the report but of two words.

249. For echoes upon echoes, there is a rare instance thereof in a place which I will now exactly describe. It is some three or four miles from Paris, near a town called Pont-Charenton; and some bird-bolt shot or more from the river of Sein. The room is a chapel or small church. The walls all standing, both at the sides and at the ends. Two rows of pillars, after the manner of isles of churches, also standing; the roof all open, not so much as any embowment near any of the walls left. There was against every pillar a stack of billets above a man's height; which the watermen that bring wood down the Sein in stacks, and not in boats, laid there, as it seemeth, for their ease. Speaking at the one end, I did hear it return the voice thirteen several times; and I have heard of others, that it would return sixteen times: for I was there about three of the clock in the afternoon: and it is best, as all other echoes are, in the evening. It is manifest that it is not echoes from several places, but a tossing of the voice, as a ball, to and fro, like to reflexions in looking glasses, where if you place one glass before and another behind, you shall see the glass behind with the image, within the glass before; and again, the

glass before in that; and divers such super-reflexions, till the "species speciei" at last die. For it is every return weaker and more shady. In like manner the voice in that chapel createth "speciem speciei," and maketh succeeding super-reflexions; for it melteth by degrees, and every reflexion is weaker than the former: so that if you speak three words, it will, perhaps, some three times report you the whole three words; and then the two latter words for some times; and then the last word alone for some times, still fading and growing weaker. And whereas in echoes of one return, it is much to hear four or five words; in this echo of so many returns upon the matter, you hear above twenty words for three.

250. The like echo upon echo, but only with two reports, hath been observed to be, if you stand between a house and a hill, and lure towards the hill. For the house will give a back echo; one taking it from the other, and the latter the weaker.

251. There are certain letters that an echo will hardly express; as S for one, especially being principal in a word. I remember well, that when I went to the echo at Pont-Charenton, there was an old Parisian, that took it to be work of spirits, and of good spirits. For, said he, call "Satan," and the echo will not deliver back the devil's name; but will say, "va t'en; which is as much in French as "apage," or avoid. And thereby I did hap to find, that an echo would not return S, being but a hissing and an interior sound.

252. Echoes are some more sudden, and chop

again as soon as the voice is delivered; as hath been partly said: others are more deliberate, that is, give more space between the voice and the echo, which is caused by the local nearness or distance: some will report a longer train of words, and some a shorter; some more loud, full as loud as the original, and sometimes more loud, and some weaker and fainter.

253. Where echoes come from several parts at the same distance, they must needs make, as it were, a choir of echoes, and so make the report greater, and even a continued echo; which you shall find in some hills that stand encompassed theatre-like.

254. It doth not yet appear that there is refraction in sounds, as well as in species visible. For I do not think, that if a sound should pass through divers mediums, as air, cloth, wood, it would deliver the sound in a differing place from that unto which it is deferred; which is the proper effect of refraction. But majoration, which is also the work of refraction, appeareth plainly in sounds, as hath been handled at full, but it is not by diversity of mediums.

Experiments in consort touching the consent and dissent between visibles and audibles.

We have "obiter," for demonstration's sake, used in divers instances the examples of the sight and things visible, to illustrate the nature of sounds: but we think good now to prosecute that comparison more fully.

Consent of visibles and audibles.

255. Both of them spread themselves in round,

and fill a whole floor or orb unto certain limits; and are carried a great way: and do languish and lessen by degrees, according to the distance of the objects from the sensories.

256. Both of them have the whole species in every small portion of the air, or medium, so as the species do pass through small crannies without confusion: as we see ordinarily in levels, as to the eye; and in crannies or chinks, as to the sound.

257. Both of them are of a sudden and easy generation and delation; and likewise perish swiftly and suddenly; as if you remove the light, or touch the bodies that give the sound.

258. Both of them do receive and carry exquisite and accurate differences; as of colours, figures, motions, distances, in visibles; and of articulate voices, tones, songs, and quaverings, in audibles.

259. Both of them, in their virtue and working, do not appear to emit any corporal substance into their mediums, or the orb of their virtue; neither again to rise or stir any evident local motion in their mediums as they pass; but only to carry certain spiritual species; the perfect knowledge of the cause whereof, being hitherto scarcely attained, we shall search and handle in due place.

260. Both of them seem not to generate or produce any other effect in nature, but such as appertaineth to their proper objects and senses, and are otherwise barren.

261. But both of them, in their own proper action, do work three manifest effects. The first, in that the stronger species drowneth the lesser; as the

light of the sun, the light of a glow-worm; the report of an ordnance, the voice: The second, in that an object of surcharge or excess destroyeth the sense; as the light of the sun the eye; a violent sound near the ear the hearing: The third, in that both of them will be reverberate; as in mirrors, and in echoes.

262. Neither of them doth destroy or hinder the species of the other, although they encounter in the same medium, as light or colour hinder not sound, nor "e contra."

263. Both of them affect the sense in living creatures, and yield objects of pleasure and dislike: yet nevertheless the objects of them do also, if it be well observed, affect and work upon dead things; namely, such as have some conformity with the organs of the two senses, as visibles work upon a looking-glass, which is like the pupil of the eye; and audibles upon the places of echo, which resemble in some sort the cavern and structure of the ear.

264. Both of them do diversly work, as they have their medium diversly disposed. So a trembling medium, as smoke, maketh the object seem to tremble, and a rising or falling medium, as winds maketh the sounds to rise or fall.

265. To both, the medium, which is the most propitious and conducible, is air, for glass or water, &c. are not comparable.

266. In both of them, where the object is fine and accurate, it conduceth much to have the sense intentive and erect, insomuch as you contract your

eye when you would see sharply; and erect your ear when you would hear attentively; which in beasts that have ears moveable is most manifest.

267. The beams of light, when they are multiplied and conglomerate, generate heat, which is a different action from the action of sight: and the multiplication and conglomeration of sounds doth generate an extreme rarefaction of the air; which is an action materiate, differing from the action of sound; if it be true, which is anciently reported, that birds with great shouts have fallen down.

Dissents of visibles and audibles.

268. The species of visibles seem to be emissions of beams from the objects seen, almost like odours, save that they are more incorporeal: but the species of audibles seem to participate more with local motion, like percussions, or impressions made upon the air. So that whereas all bodies do seem to work in two manners, either by the communication of their natures, or by the impressions and signatures of their motions; the diffusion of species visible seemeth to participate more of the former operation, and the species audible of the latter.

269. The species of audibles seem to be carried more manifestly through the air than the species of visibles: for I conceive that a contrary strong wind will not much hinder the sight of visibles, as it will do the hearing of sounds.

270. There is one difference above all others between visibles and audibles, that is the most re-

markable, as that whereupon many smaller differences do depend: namely, that visibles, except lights, are carried in right lines, and audibles in arcuate lines. Hence it cometh to pass, that visibles do not intermingle and confound one another, as hath been said before, but sounds do. Hence it cometh, that the solidity of bodies doth not much hinder the sight, so that the bodies be clear, and the pores in a right line, as in glass, crystal, diamonds, water, &c. but a thin scarf or handkerchief, though they be bodies nothing so solid, hinder the sight: whereas, contrariwise, these porous bodies do not much hinder the hearing, but solid bodies do almost stop it, or at the least attenuate it. Hence also it cometh, that to the reflexion of visibles small glasses suffice; but to the reverberation of audibles are required greater spaces, as hath likewise been said before.

271. Visibles are seen further off than sounds are heard, allowing nevertheless the rate of their bigness, for otherwise a great sound will be heard further off than a small body seen.

272. Visibles require, generally, some distance between the object and the eye, to be better seen; whereas in audibles, the nearer the approach of the sound is to the sense, the better. But in this there may be a double error. The one because to seeing there is required light; and any thing that toucheth the pupil of the eye all over excludeth the light. For I have heard of a person very credible, who himself was cured of a cataract in one of his eyes, that while the silver needle did work upon the sight

of his eye, to remove the film of the cataract, he never saw any thing more clear or perfect than that white needle: which, no doubt, was, because the needle was lesser than the pupil of the eye, and so took not the light from it. The other error may be, for that the object of sight doth strike upon the pupil of the eye directly without any interception; whereas the cave of the ear doth hold off the sound a little from the organ: and so nevertheless there is some distance required in both.

273. Visibles are swiftlier carried to the sense than audibles; as appeareth in thunder and lightning, flame and report of a piece, motion of the air in hewing of wood. All which have been set down heretofore, but are proper for this title.

274. I conceive also, that the species of audibles do hang longer in the air than those of visibles: for although even those of visibles do hang some time, as we see in rings turned, that shew like spheres; in lute-strings fillipped; a fire-brand carried along, which leaveth a train of light behind it; and in the twilight, and the like: yet I conceive that sounds stay longer, because they are carried up and down with the wind; and because of the distance of the time in ordnance discharged, and heard twenty miles off.

275. In visibles there are not found objects so odious and ingrate to the sense as in audibles. For foul sights do rather displease, in that they excite the memory of foul things, than in the immediate objects. And therefore in pictures, those foul sights do not

much offend; but in audibles, the grating of a saw, when it is sharpened, doth offend so much, as it setteth the teeth on edge. And any of the harsh discords in music the ear doth straightways refuse.

276. In visibles, after great light, if you come suddenly into the dark, or contrariwise, out of the dark into a glaring light, the eye is dazzled for a time, and the sight confused; but whether any such effect be after great sounds, or after a deep silence, may be better inquired. It is an old tradition, that those that dwell near the cataracts of Nilus are strucken deaf: but we find no such effect in cannoniers, nor millers, nor those that dwell upon bridges.

277. It seemeth that the impression of colour is so weak, as it worketh not but by a cone of direct beams, or right lines, whereof the basis is in the object, and the vertical point in the eye; so as there is a corradiation and conjunction of beams; and those beams so sent forth, yet are not of any force to beget the like borrowed or second beams, except it be by reflexion, whereof we speak not. For the beams pass, and give little tincture to that air which is adjacent; which if they did, we should see colours out of a right line. But as this is in colours, so otherwise it is in the body of light. For when there is a skreen between the candle and the eye, yet the light passeth to the paper whereon one writeth; so that the light is seen where the body of the flame is not seen, and where any colour, if it were placed where the body of the flame is, would

not be seen. I judge that sound is of this latter nature; for when two are placed on both sides of a wall, and the voice is heard, I judge it is not only the original sound which passeth in an arched line; but the sound which passeth above the wall in a right line, begetteth the like motion round about it as the first did, though more weak.

Experiments in consort touching the sympathy or antipathy of sounds one with another.

278. All concords and discords of music are, no doubt, sympathies and antipathies of sounds. And so, likewise, in that music which we call broken music, or consort music, some consorts of instruments are sweeter than others, a thing not sufficiently yet observed: as the Irish harp and base viol agree well: the recorder and stringed music agree well: organs and the voice agree well, &c. But the virginals and the lute, or the Welsh harp and Irish harp, or the voice and pipes alone, agree not so well: but for the melioration of music there is yet much left, in this point of exquisite consorts, to try and inquire.

279. There is a common observation, that if a lute or viol be laid upon the back, with a small straw upon one of the strings, and another lute or viol be laid by it; and in the other lute or viol the unison to that string be strucken, it will make the string move, which will appear both to the eye, and by the straw's falling off. The like will be, if the diapason or eighth to that string be strucken, either in the same lute or viol, or in others lying by: but in none

of these there is any report of sound that can be discerned, but only motion.

280. It was devised, that a viol should have a lay of wire-strings below, as close to the belly as a lute, and then the strings of guts mounted upon a bridge as in ordinary viols: to the end that by this means the upper strings strucken should make the lower resound by sympathy, and so make the music the better; which if it be to purpose, then sympathy worketh as well by report of sound as by motion. But this device I conceive to be of no use, because the upper strings, which are stopped in great variety, cannot maintain a diapason or unison with the lower, which are never stopped. But if it should be of use at all, it must be in instruments which have no stops, as virginals and harps; wherein trial may be made of two rows of strings, distant the one from the other.

281. The experiment of sympathy may be transferred, perhaps, from instruments of strings to other instruments of sound. As to try, if there were in one steeple two bells of unison, whether the striking of the one would move the other, more than if it were another accord: and so in pipes, if they be of equal bore and sound, whether a little straw or feather would move in the one pipe, when the other is blown at an unison.

282. It seemeth, both in ear and eye, the instrument of sense hath a sympathy or similitude with that which giveth the reflection, as hath been touched before; for as the sight of the eye is like a crystal,

or glass, or water; so is the ear a sinuous cave, with a hard bone to stop and reverberate the sound; which is like to the places that report echoes.

Experiments in consort touching the hindering or helping of the hearing.

283. When a man yawneth, he cannot hear so well. The cause is, for that the membrane of the ear is extended; and so rather casteth off the sound than draweth it to.

284. We hear better when we hold our breath than contrary: insomuch, as in all listening to attain a sound afar off men hold their breath. The cause is for that in all expiration the motion is outwards; and therefore rather driveth away the voice than draweth it: and besides we see, that in all labour to do things with any strength, we hold the breath; and listening after any sound that is heard with difficulty, is a kind of labour.

285. Let it be tried, for the help of the hearing, and I conceive it likely to succeed, to make an instrument like a tunnel; the narrow part whereof may be of the bigness of the hole of the ear; and the broader end much larger, like a bell at the skirts; and the length half a foot or more. And let the narrow end of it be set close to the ear: and mark whether any sound, abroad in the open air, will not be heard distinctly from farther distance, than without that instrument; being, as it were, an ear-spectacle. And I have heard there is in Spain an

instrument in use to be set to the ear, that helpeth somewhat those that are thick of hearing.

286. If the mouth be shut close, nevertheless there is yielded by the roof of the mouth a murmur, such as is used by dumb men. But if the nostrils be likewise stopped, no such murmur can be made, except it be in the bottom of the palate towards the throat. Whereby it appeareth manifestly, that a sound in the mouth, except such as aforesaid, if the mouth be stopped, passeth from the palate through the nostrils.

Experiments in consort touching the spiritual and fine nature of sounds.

287. The repercussion of sounds, which we call echo, is a great argument of the spiritual essence of sounds. For if it were corporeal, the repercussion should be created in the same manner, and by like instruments, with the original sound: but we see what a number of exquisite instruments must concur in speaking of words, whereof there is no such matter in the returning of them, but only a plain stop and repercussion.

288. The exquisite differences of articulate sounds, carried along in the air, shew that they cannot be signatures or impressions in the air, as hath been well refuted by the ancients. For it is true, that seals make excellent impressions; and so it may be thought of sounds in their first generation; but then the delation and continuance of them with-

out any new sealing, shew apparently they cannot be impressions.

289. All sounds are suddenly made, and do suddenly perish: but neither that, nor the exquisite differences of them, is matter of so great admiration: for the quaverings and warblings in lutes and pipes are as swift; and the tongue, which is no very fine instrument, doth in speech make no fewer motions than there be letters in all the words which are uttered. But that sounds should not only be so speedily generated, but carried so far every way in such a momentary time, deserveth more admiration. As for example, if a man stand in the middle of a field and speak aloud, he shall be heard a furlong in round; and that shall be in articulate sounds; and those shall be entire in every little portion of the air; and this shall be done in the space of less than a minute.

290. The sudden generation and perishing of sounds must be one of these two ways. Either that the air suffereth some force by sound, and then restoreth itself as water doth; which being divided, maketh many circles, till it restore itself to the natural consistence: or otherwise, that the air doth willingly imbibe the sound as grateful, but cannot maintain it; for that the air hath, as it should seem, a secret and hidden appetite of receiving the sound at the first; but then other gross and more materiate qualities of the air straightways suffocate it, like unto flame, which is generated with alacrity, but straight quenched by the enmity of the air or other ambient bodies.

There be these differences in general, by which sounds are divided: 1. Musical, immusical. 2. Treble, base. 3. Flat, sharp. 4. Soft, loud. 5. Exterior, interior. 6. Clean, harsh, or purling. 7. Articulate, inarticulate.

We have laboured, as may appear, in this inquisition of sounds diligently; both because sound is one of the most hidden portions of nature, as we said in the beginning, and because it is a virtue which may be called incorporeal and immateriate, whereof there be in nature but few. Besides, we were willing, now in these our first centuries, to make a pattern or precedent of an exact inquisition; and we shall do the like hereafter in some other subjects which require it. For we desire that men should learn and perceive, how severe a thing the true inquisition of nature is; and should accustom themselves by the light of particulars to enlarge their minds to the amplitude of the world, and not reduce the world to the narrowness of their minds.

Experiment solitary touching the orient colours in dissolution of metals.

291. Metals give orient and fine colours in dissolutions; as gold giveth an excellent yellow, quicksilver an excellent green, tin giveth an excellent azure: likewise in their putrefactions or rusts; as vermilion, verdigrease, bise, cirrus, &c. and likewise in their vitrifications. The cause is, for that by their strength of body they are able to endure the fire or strong waters, and to be put into an equal

posture, and again to retain part of their principal spirit; which two things, equal posture and quick spirits, are required chiefly to make colours lightsome.

Experiment solitary touching prolongation of life.

292. It conduceth unto long life, and to the more placid motion of the spirits, which thereby do less prey and consume the juice of the body, either that men's actions be free and voluntary, that nothing be done "invita Minerva," but "secundum genium;" or on the other side, that the actions of men be full of regulation and commands within themselves: for then the victory and performing of the command giveth a good disposition to the spirits, especially if there be a proceeding from degree to degree; for then the sense of the victory is the greater. An example of the former of these is in a country life; and of the latter in monks and philosophers, and such as do continually enjoin themselves.

Experiment solitary touching appetite of union in bodies.

293. It is certain that in all bodies there is an appetite of union and evitation of solution of continuity; and of this appetite there be many degrees; but the most remarkable and fit to be distinguished are three. The first in liquors; the second in hard bodies; and the third in bodies cleaving or tenacious. In liquors this appetite is weak: we see in liquors the threading of them in stillicides, as hath

been said; the falling of them in round drops, which is the form of union, and the staying of them for a little time in bubbles and froth. In the second degree or kind, this appetite is strong; as in iron, in stone, in wood, &c. In the third, this appetite is in a medium between the other two: for such bodies do partly follow the touch of another body, and partly stick and continue to themselves; and therefore they rope, and draw themselves in threads, as we see in pitch, glue, birdlime, &c. But note, that all solid bodies are cleaving more or less: and that they love better the touch of somewhat that is tangible, than of air. For water in small quantity cleaveth to any thing that is solid; and so would metal too, if the weight drew it not off. And therefore gold foliate, or any metal foliate cleaveth: but those bodies which are noted to be clammy and cleaving, are such as have a more indifferent appetite at once to follow another body, and to hold to themselves. And therefore they are commonly bodies ill mixed; and which take more pleasure in a foreign body, than in preserving their own consistence, and which have little predominance in drought or moisture.

Experiment solitary touching the like operations of heat and time.

294. Time and heat are fellows in many effects. Heat drieth bodies that do easily expire; as parchment, leaves, roots, clay, &c. And so doth time or age arefy; as in the same bodies, &c. Heat dissolveth and melteth bodies that keep in their spirits;

as in divers liquefactions: and so doth time in some bodies of a softer consistence, as is manifest in honey, which by age waxeth more liquid, and the like in sugar; and so in old oil, which is ever more clear and more hot in medicinable use. Heat causeth the spirits to search some issue out of the body; as in the volatility of metals; and so doth time; as in the rust of metals. But generally heat doth that in small time which age doth in long.

Experiment solitary touching the differing operation of fire and time.

295. Some things which pass the fire are softest at first, and by time grow hard, as the crumb of bread. Some are harder when they come from the fire, and afterwards give again, and grow soft, as the crust of bread, bisket, sweet-meats, salt, &c. The cause is, for that in those things which wax hard with time, the work of the fire is a kind of melting; and in those that wax soft with time, contrariwise, the work of the fire is a kind of baking; and whatsoever the fire baketh, time doth in some degree dissolve.

Experiment solitary touching motions by imitation.

296. Motions pass from one man to another, not so much by exciting imagination as by invitation; especially if there be an aptness or inclination before. Therefore gaping, or yawning, and stretching do pass from man to man; for that that causeth gaping and

stretching is, when the spirits are a little heavy by any vapour, or the like. For then they strive, as it were, to wring out and expel that which loadeth them. So men drowsy, and desirous to sleep, or before the fit of an ague, do use to yawn and stretch, and do likewise yield a voice or sound, which is an interjection of expulsion: so that if another be apt and prepared to do the like, he followeth by the sight of another. So the laughing of another maketh to laugh.

Experiment solitary touching infectious diseases.

297. There be some known diseases that are infectious; and others that are not. Those that are infectious are, first, such as are chiefly in the spirits, and not so much in the humours, and therefore pass easily from body to body; such are pestilences, lippitudes, and such like. Secondly, such as taint the breath, which we see passeth manifestly from man to man, and not invisibly, as the affects of the spirits do; such are consumptions of the lungs, &c. Thirdly, such as come forth to the skin, and therefore taint the air or the body adjacent, especially if they consist in an unctuous substance not apt to dissipate, such are scabs and leprosy. Fourthly, such as are merely in the humours, and not in the spirits, breath, or exhalations; and therefore they never infect but by touch only; and such a touch also as cometh within the "epidermis;" as the venom of the French pox, and the biting of a mad dog.

Experiment solitary touching the incorporation of powders and liquors.

298. Most powders grow more close and coherent by mixture of water, than by mixture of oil, though oil be the thicker body; as meal, &c. The reason is the congruity of bodies; which if it be more, maketh a perfecter imbibition and incorporation; which in most powders is more between them and water, than between them and oil: but painters colours ground, and ashes, do better incorporate with oil.

Experiment solitary touching exercise of the body.

299. Much motion and exercise is good for some bodies; and sitting and less motion for others. If the body be hot and void of superfluous moistures, too much motion hurteth: and it is an error in physicians, to call too much upon exercise. Likewise men ought to beware, that they use not exercise and a spare diet both: but if much exercise, then a plentiful diet; and if sparing diet, then little exercise. The benefits that come of exercise are, first, that it sendeth nourishment into the parts more forcibly. Secondly, that it helpeth to excern by sweat, and so maketh the parts assimilate the more perfectly. Thirdly, that it maketh the substance of the body more solid and compact, and so less apt to be consumed and depredated by the spirits. The evils that come of exercise are, first, that it maketh the spirits more hot and predatory. Secondly, that

it doth absorb likewise, and attenuate too much the moisture of the body. Thirdly, that it maketh too great concussion, especially if it be violent, of the inward parts, which delight more in rest. But generally exercise, if it be much, is no friend to prolongation of life, which is one cause why women live longer than men, because they stir less.

Experiment solitary touching meats that induce satiety.

300. Some food we may use long, and much, without glutting, as bread, flesh that is not fat or rank, &c. Some other, though pleasant, glutteth sooner, as sweet-meats, fat meats, &c. The cause is, for that appetite consisteth in the emptiness of the mouth of the stomach, or possessing it with somewhat that is astringent, and therefore cold and dry. But things that are sweet and fat are more filling, and do swim and hang more about the mouth of the stomach, and go not down so speedily: and again turn sooner to choler, which is hot, and ever abateth the appetite. We see also that another cause of satiety is an over-custom, and of appetite is novelty, and therefore meats, if the same be continually taken, induce loathing. To give the reason of the distaste of satiety, and of the pleasure in novelty, and to distinguish not only in meats and drinks, but also in motions, loves, company, delights, studies, what they be that custom maketh more grateful, and what more tedious, were a large field. But for meats, the cause is attraction, which is

quicker, and more excited towards that which is new, than towards that whereof there remaineth a relish by former use. And, generally, it is a rule, that whatsoever is somewhat ingrate at first, is made grateful by custom; but whatsoever is too pleasing at first, groweth quickly to satiate.

NATURAL HISTORY.

CENTURY IV.

Experiments in consort touching the clarification of liquors, and the accelerating thereof.

ACCELERATION of time, in works of nature, may well be esteemed "inter magnalia naturæ." And even in divine miracles, accelerating of the time is next to the creating of the matter. We will now therefore proceed to the inquiry of it: and for acceleration of germination, we will refer it over unto the place where we shall handle the subject of plants generally, and will now begin with other accelerations.

301. Liquors are, many of them, at the first thick and troubled; as muste, wort, juices of fruits, or herbs expressed, &c. and by time they settle and clarify. But to make them clear before the time is a great work, for it is a spur to nature, and putteth her out of her pace: and, besides, it is of good use for making drinks and sauces potable and serviceable speedily. But to know the means of accelerating clarification, we must first know the causes of clarification. The first cause is, by the separation of the grosser parts of the liquor from the finer. The

second, by the equal distribution of the spirits of the liquor with the tangible parts: for that ever representeth bodies clear and untroubled. The third, by the refining the spirit itself, which thereby giveth to the liquor more splendour and more lustre.

302. First, for separation, it is wrought by weight, as in the ordinary residence or settlement of liquors; by heat, by motion, by precipitation, or sublimation, that is, a calling of the several parts either up or down, which is a kind of attraction; by adhesion, as when a body more viscous is mingled and agitated with the liquor, which viscous body, afterwards severed, draweth with it the grosser parts of the liquor; and lastly, by percolation or passage.

303. Secondly, for the even distribution of the spirits, it is wrought by gentle heat; and by agitation or motion, for of time we speak not, because it is that we would anticipate and represent; and it is wrought also by mixture of some other body which hath a virtue to open the liquor, and to make the spirits the better pass through.

304. Thirdly, for the refining of the spirit, it is wrought likewise by heat, by motion, and by mixture of some body which hath virtue to attenuate. So therefore, having shewn the causes, for the accelerating of clarification in general, and the inducing of it, take these instances and trials.

305. It is in common practice to draw wine or beer from the lees, which we call racking, whereby it will clarify much the sooner; for the lees, though they keep the drink in heart, and make it lasting,

yet withal they cast up some spissitude: and this instance is to be referred to separation.

306. On the other side it were good to try, what the adding to the liquor more lees than his own will work; for though the lees do make the liquor turbid, yet they refine the spirits. Take therefore a vessel of new beer, and take another vessel of new beer, and rack the one vessel from the lees, and pour the lees of the racked vessel into the unracked vessel, and see the effect: this instance is referred to the refining of the spirits.

307. Take new beer, and put in some quantity of stale beer into it, and see whether it will not accelerate the clarification, by opening the body of the beer, and cutting the grosser parts, whereby they may fall down into lees. And this instance again is referred to separation.

308. The longer malt or herbs, or the like, are infused in liquor, the more thick and troubled the liquor is; but the longer they be decocted in the liquor, the clearer it is. The reason is plain, because in infusion, the longer it is, the greater is the part of the gross body that goeth into the liquor: but in decoction, though more goeth forth, yet it either purgeth at the top, or settleth at the bottom. And therefore the most exact way to clarify is, first, to infuse, and then to take off the liquor and decoct it; as they do in beer, which hath malt first infused in the liquor, and is afterwards boiled with the hop. This also is referred to separation.

309. Take hot embers, and put them about a

bottle filled with new beer, almost to the very neck; let the bottle be well stopped, lest it fly out: and continue it, renewing the embers every day, by the space of ten days, and then compare it with another bottle of the same beer set by. Take also lime both quenched and unquenched, and set the bottles in them "ut supra." This instance is referred both to the even distribution, and also to the refining of the spirits by heat.

310. Take bottles, and swing them, or carry them in a wheel-barrow upon rough ground twice in a day, but then you may not fill the bottles full, but leave some air; for if the liquor come close to the stopple, it cannot play nor flower: and when you have shaken them will either way, pour the drink into another bottle stopped close after the usual manner, for if it stay with much air in it, the drink will pall; neither will it settle so perfectly in all the parts. Let it stand some twenty-four hours, then take it, and put it again into a bottle with air, "ut supra;" and thence into a bottle stopped, "ut supra:" and so repeat the same operation for seven days. Note that in the emptying of one bottle into another, you must do it swiftly lest the drink pall. It were good also to try it in a bottle with a little air below the neck, without emptying. This instance is referred to the even distribution and refining of the spirits by motion.

311. As for percolation inward and outward, which belongeth to separation, trial would be made of clarifying by adhesion, with milk put into new

beer, and stirred with it: for it may be that the grosser part of the beer will cleave to the milk: the doubt is, whether the milk will sever well again; which is soon tried. And it is usual in clarifying hippocras to put in milk; which after severeth and carrieth with it the grosser parts of the hippocras, as hath been said elsewhere. Also for the better clarification by percolation, when they tun new beer, they use to let it pass through a strainer, and it is like the finer the strainer is, the clearer it will be.

Experiments in consort touching maturation, and the accelerating thereof. And first, touching the maturation and quickening of drinks. And next, touching the maturation of fruits.

The accelerating of maturation we will now inquire of. And of maturation itself. It is of three natures. The maturation of fruits, the maturation of drinks, and the maturation of impostumes and ulcers. This last we refer to another place, where we shall handle experiments medicinal. There be also other maturations, as of metals, &c. whereof we will speak as occasion serveth. But we will begin with that of drinks, because it hath such affinity with the clarification of liquors.

312. For the maturation of drinks, it is wrought by the congregation of the spirits together, whereby they digest more perfectly the grosser parts: and it is effected partly by the same means that clarification is, whereof we spake before; but then note,

that an extreme clarification doth spread the spirits so smooth, as they become dull, and the drink dead, which ought to have a little flowering. And therefore all your clear amber drink is flat.

313. We see the degrees of maturation of drinks, in muste, in wine, as it is drunk, and in vinegar. Whereof muste hath not the spirits well congregated; wine hath them well united, so as they make the parts somewhat more oily; vinegar hath them congregated, but more jejune, and in smaller quantity, the greatest and finest spirit and part being exhaled: for we see vinegar is made by setting the vessel of wine against the hot sun; and therefore vinegar will not burn; for that much of the finer parts is exhaled.

314. The refreshing and quickening of drink palled or dead, is by enforcing the motion of the spirit: so we see that open weather relaxeth the spirit, and maketh it more lively in motion. We see also bottling of beer or ale, while it is new and full of spirit, so that it spirteth when the stopple is taken forth, maketh the drink more quick and windy. A pan of coals in the cellar doth likewise good, and maketh the drink work again. New drink put to drink that is dead provoketh it to work again: nay, which is more, as some affirm, a brewing of new beer set by old beer, maketh it work again. It were good also to enforce the spirits by some mixtures, that may excite and quicken them; as by putting into the bottles, nitre, chalk, lime, &c. We see cream is matured, and made to rise more

speedily by putting in cold water; which as it seemeth, getteth down the whey.

315. It is tried, that the burying of bottles of drink well stopped, either in dry earth a good depth; or in the bottom of a well within water; and best of all, the hanging of them in a deep well somewhat above the water for some fortnight's space, is an excellent means of making drink fresh and quick; for the cold doth not cause any exhaling of the spirits at all, as heat doth, though it rarifieth the rest that remain; but cold maketh the spirits vigorous, and irritateth them, whereby they incorporate the parts of the liquor perfectly.

316. As for the maturation of fruits, it is wrought by the calling forth of the spirits of the body outward, and so spreading them more smoothly: and likewise by digesting in some degree the grosser parts; and this is effected by heat, motion, attraction, and by a rudiment of putrefaction; for the inception of putrefaction hath in it a maturation.

317. There were taken apples, and laid in straw, in hay, in flour, in chalk, in lime; covered over with onions; covered over with crabs, closed up in wax, shut in a box, &c. There was also an apple hanged up in smoke, of all which the experiment sorted in this manner.

318. After a month's space, the apple inclosed in wax was as green and fresh as at the first putting in, and the kernels continued white. The cause is, for that all exclusion of open air, which is ever predatory, maintaineth the body in its first freshness and

moisture; but the inconvenience is, that it tasteth a little of the wax: which, I suppose, in a pomegranate, or some such thick-coated fruit, it would not do.

319. The apple hanged in the smoke, turned like an old mellow apple, wrinkled, dry, soft, sweet, yellow within. The cause is, for that such a degree of heat, which doth neither melt nor scorch (for we see that in a greater heat, a roast apple softeneth and melteth; and pigs feet, made of quarters of wardens, scorch and have a skin of cole,) doth mellow, and not adure: the smoke also maketh the apple, as it were, sprinkled with soot, which helpeth to mature. We see that in drying of pears and prunes in the oven, and removing of them often as they begin to sweat, there is a like operation; but that is with a far more intense degree of heat.

320. The apples covered in the lime and ashes were well matured, as appeared both in their yellowness and sweetness. The cause is, for that that degree of heat which is in lime and ashes, being a smothering heat, is of all the rest most proper, for it doth neither liquefy nor arefy, and that is true maturation. Note, that the taste of those apples was good, and therefore it is the experiment fittest for use.

321. The apples covered with crabs and onions were likewise well matured. The cause is, not any heat; but for that the crabs and the onions draw forth the spirits of the apple, and spread them equally throughout the body, which taketh away

hardness. So we see one apple ripeneth against another. And therefore in making of cyder they turn the apples first upon a heap. So one cluster of grapes that toucheth another whilst it groweth, ripeneth faster; "botrus contra botrum citius ma-"turescit."

322. The apples in hay and the straw ripened apparently, though not so much as the other; but the apple in the straw more. The cause is, for that the hay and straw have a very low degree of heat, but yet close and smothering, and which drieth not.

323. The apple in the close box was ripened also: the cause is, for that all air kept close hath a degree of warmth; as we see in wool, fur, plush, &c. Note, that all of these were compared with another apple of the same kind that lay of itself; and in comparison of that were more sweet and more yellow, and so appeared to be more ripe.

324. Take an apple or pear, or other like fruit, and roll it upon a table hard: we see in common experience, that the rolling doth soften and sweeten the fruit presently; which is nothing but the smooth distribution of the spirits into the parts; for the unequal distribution of the spirits maketh the harshness: but this hard rolling is between concoction and a simple maturation; therefore, if you should roll them but gently, perhaps twice a day, and continue it some seven days, it is like they would mature more finely, and like unto the natural maturation.

325. Take an apple, and cut out a piece of the top, and cover it, to see whether that solution of continuity will not hasten a maturation: we see that where a wasp, or a fly, or a worm hath bitten, in a grape, or any fruit, it will sweeten hastily.

326. Take an apple, &c. and prick it with a pin full of holes, not deep, and smear it a little with sack, or cinnamon water, or spirit of wine, every day for ten days, to see if the virtual heat of the wine or strong waters will not mature it.

In these trials also, as was used in the first, set another of the same fruits by to compare them; and try them by their yellowness and by their sweetness.

Experiment solitary touching the making of gold.

The world hath been much abused by the opinion of making of gold: the work itself I judge to be possible; but the means hitherto propounded to effect it are, in the practice, full of error and imposture, and in the theory, full of unsound imaginations. For to say, that nature hath an intention to make all metals gold; and that, if she were delivered from impediments, she would perform her own work; and that, if the crudities, impurities, and leprosities of metals were cured, they would become gold; and that a little quantity of the medicine, in the work of projection, will turn a sea of the baser metal into gold by multiplying: all these are but dreams; and so are many other grounds of alchemy. And to help the matter, the alchemists call in likewise many

vanities out of astrology, natural magic, superstitious interpretations of Scriptures, auricular traditions, feigned testimonies of ancient authors, and the like. It is true, on the other side, they have brought to light not a few profitable experiments, and thereby made the world some amends. But we, when we shall come to handle the version and transmutation of bodies, and the experiments concerning metals and minerals, will lay open the true ways and passages of nature, which may lead to this great effect. And we commend the wit of the Chineses, who despair of making of gold, but are mad upon the making of silver: for certain it is, that it is more difficult to make gold, which is the most ponderous and materiate amongst metals, of other metals less ponderous and less materiate, than "via versa," to make silver of lead or quicksilver, both which are more ponderous than silver; so that they need rather a further degree of fixation than any condensation. In the mean time, by occasion of handling the axioms touching maturation, we will direct a trial touching the maturing of metals, and thereby turning some of them into gold: for we conceive indeed, that a perfect good concoction, or digestion, or maturation of some metals, will produce gold. And hereby we call to mind, that we knew a Dutchman, that had wrought himself into the belief of a great person, by undertaking that he could make gold: whose discourse was, that gold might be made; but that the alchemists over-fired the work: for, he said, the making of gold did require a very tem-

perate heat, as being in nature a subterrany work, where little heat cometh; but yet more to the making of gold than of any other metal; and therefore that he would do it with a great lamp that should carry a temperate and equal heat; and that it was the work of many months. The device of the lamp was folly; but the over-firing now used, and the equal heat to be required, and the making it a work of some good time, are no ill discourses.

We resort therefore to our axioms of maturation, in effect touched before. The first is, that there be used a temperate heat; for they are ever temperate heats that digest and mature: wherein we mean temperate according to the nature of the subject; for that may be temperate to fruits and liquors, which will not work at all upon metals. The second is, that the spirits of the metal be quickened, and the tangible parts opened: for without those two operations, the spirit of the metal wrought upon will not be able to digest the parts. The third is, that the spirits do spread themselves even, and move not subsultorily, for that will make the parts close and pliant. And this requireth a heat that doth not rise and fall, but continue as equal as may be. The fourth is, that no part of the spirit be emitted but detained: for if there be emission of spirit, the body of the metal will be hard and churlish. And this will be performed, partly by the temper of the fire, and partly by the closeness of the vessel. The fifth is, that there be choice made of the likeliest and best

prepared metal for the version, for that will facilitate the work. The sixth is, that you give time enough for the work; not to prolong hopes, as the alchemists do, but indeed to give nature a convenient space to work in. These principles are most certain and true; we will now derive a direction of trial out of them, which may, perhaps, by further meditation, be improved.

327. Let there be a small furnace made of a temperate heat; let the heat be such as may keep the metal perpetually molten, and no more; for that above all importeth to the work. For the material, take silver, which is the metal that in nature symbolizeth most with gold; put in also with the silver, a tenth part of quicksilver, and a twelfth part of nitre, by weight; both these to quicken and open the body of the metal; and so let the work be continued by the space of six months at the least. I wish also, that there be at sometimes an injection of some oiled substance, such as they use in the recovering of gold, which by vexing with separations hath been made churlish; and this is to lay the parts more close and smooth, which is the main work. For gold, as we see, is the closest, and therefore the heaviest of metals; and is likewise the most flexible and tensible. Note, that to think to make gold of quicksilver, because it is the heaviest, is a thing not to be hoped; for quicksilver will not indure the manage of the fire. Next to silver, I think copper were fittest to be the material.

Experiment solitary touching the nature of gold.

328. Gold hath these natures; greatness of weight, closeness of parts, fixation, pliantness or softness, immunity from rust, colour or tincture of yellow. Therefore the sure way, though most about, to make gold, is to know the causes of the several natures before rehearsed, and the axioms concerning the same. For if a man can make a metal that hath all these properties, let men dispute whether it be gold or no.

Experiments in consort touching the inducing and accelerating of putrefaction.

The inducing and accelerating of putrefaction, is a subject of a very universal inquiry: for corruption is a reciprocal to generation: and they two are as nature's two terms or boundaries; and the guides to life and death. Putrefaction is the work of the spirits of bodies, which ever are unquiet to get forth and congregate with the air, and to enjoy the sun-beams. The getting forth, or spreading of the spirits, which is a degree of getting forth, hath five differing operations. If the spirits be detained within the body, and move more violently, there followeth colliquation, as in metals, &c. If more mildly, there followeth digestion or maturation, as in drinks and fruits. If the spirits be not merely detained, but protrude a little, and that motion be confused and inordinate, there followeth putrefac-

tion; which ever dissolveth the consistence of the body into much inequality, as in flesh, rotten fruits, shining wood, &c. and also in the rust of metals. But if that motion be in a certain order, there followeth vivification and figuration; as both in living creatures bred of putrefaction, and in living creatures perfect. But if the spirits issue out of the body, there followeth desiccation, induration, consumption, &c. as in brick, evaporation of bodies liquid, &c.

329. The means to induce and accelerate putrefaction, are, first, by adding some crude or watery moisture; as in wetting of any flesh, fruit, wood, with water, &c. for contrariwise unctuous and oily substances preserve.

330. The second is by invitation or excitation: as when a rotten apple lieth close to another apple that is sound; or when dung, which is a substance already putrified, is added to other bodies. And this is also notably seen in church-yards, where they bury much, where the earth will consume the corpse in far shorter time than other earth will.

331. The third is by closeness and stopping, which detaineth the spirits in prison more than they would; and thereby irritateth them to seek issue; as in corn and clothes which wax musty; and therefore open air, which they call "aër perflabilis," doth preserve: and this doth appear more evidently in agues, which come, most of them, of obstructions, and penning the humours which thereupon putrify.

332. The fourth is by solution of continuity; as

we see an apple will rot sooner if it be cut or pierced; and so will wood, &c. And so the flesh of creatures alive, where they have received any wound.

333. The fifth is either by the exhaling or by the driving back of the principal spirits which preserve the consistence of the body; so that when their government is dissolved, every part returneth to his nature or homogeny. And this appeareth in urine and blood when they cool, and thereby break: it appeareth also in the gangrene, or mortification of flesh, either by opiates or by intense colds. I conceive also the same effect is in pestilences; for that the malignity of the infecting vapour danceth the principal spirits, and maketh them fly and leave their regiment; and then the humours, flesh, and secondary spirits, do dissolve and break, as in an anarchy.

334. The sixth is when a foreign spirit, stronger and more eager than the spirit of the body, entereth the body, as in the stinging of serpents. And this is the cause generally, that upon all poisons followeth swelling: and we see swelling followeth also when the spirits of the body itself congregate too much, as upon blows and bruises; or when they are pent in too much, as in swelling upon cold. And we see also, that the spirits coming of putrefaction of humours in agues, &c. which may be counted as foreign spirits, though they be bred within the body, do extinguish and suffocate the natural spirits and heat.

335. The seventh is by such a weak degree of heat, as setteth the spirits in a little motion, but is not able either to digest the parts, or to issue the

spirits; as is seen in flesh kept in a room that is not cool; whereas in a cool and wet larder it will keep longer. And we see that vivification, whereof putrefaction is the bastard brother, is effected by such soft heats; as the hatching of eggs, the heat of the womb, &c.

336. The eighth is by the releasing of the spirits, which before were close kept by the solidness of their coverture, and thereby their appetite of issuing checked; as in the artificial rusts induced by strong waters in iron, lead, &c. and therefore wetting hasteneth rust or putrefaction of any thing, because it softeneth the crust for the spirits to come forth.

337. The ninth is by the interchange of heat and cold, or wet and dry; as we see in the mouldering of earth in frosts and sun; and in the more hasty rotting of wood that is sometimes wet, sometimes dry.

338. The tenth is by time, and the work and procedure of the spirits themselves, which cannot keep their station; especially if they be left to themselves, and there be not agitation or local motion. As we see in corn not stirred, and men's bodies not exercised.

339. All moulds are inceptions of putrefaction; as the moulds of pies and flesh; the moulds of oranges and lemons, which moulds afterwards turn into worms, or more odious putrefactions; and therefore commonly prove to be of ill odour. And if the body be liquid ,and not apt to putrify totally, it will cast up a mother in the top, as the mothers of distilled waters.

340. Moss is a kind of mould of the earth and trees. But it may be better sorted as a rudiment of germination, to which we refer it.

Experiments in consort touching prohibiting and preventing putrefaction.

It is an inquiry of excellent use to inquire of the means of preventing or staying putrefaction; for therein consisteth the means of conservation of bodies: for bodies have two kinds of dissolutions; the one by consumption and desiccation, the other by putrefaction. But as for the putrefactions of the bodies of men and living creatures, as in agues, worms, consumptions of the lungs, impostumes, and ulcers both inwards and outwards, they are a great part of physic and surgery; and therefore we will reserve the inquiry of them to the proper place, where we shall handle medicinal experiments of all sorts. Of the rest we will now enter into an inquiry: wherein much light may be taken from that which hath been said of the means to induce or accelerate putrefaction: for the removing that which caused putrefaction, doth prentve and avoid putrefaction.

341. The first means of prohibiting or checking putrefaction is cold: for so we see that meat and drink will last longer unputrified, or unsoured, in winter than in summer: and we see that flowers and fruits, put in conservatories of snow, keep fresh. And this worketh by the detention of the spirits, and constipation of the tangible parts.

342. The second is astriction: for astriction pro

hibiteth dissolution; as we see generally in medicines, whereof such as are astringents do inhibit putrefaction: and by the same reason of astringency, some small quantity of oil of vitriol will keep fresh water long from putrifying. And this astriction is in a substance that hath a virtual cold; and it worketh partly by the same means that cold doth.

343. The third is the excluding of the air; and again, the exposing to the air: for these contraries, as it cometh often to pass, work the same effect, according to the nature of the subject matter. So we see, that beer or wine, in bottles close stopped, last long: that the garners under ground keep corn longer than those above ground; and that fruit closed in wax keepeth fresh; and likewise bodies put in honey and flour keep more fresh: and liquors, drinks, and juices, with a little oil cast on the top, keep fresh. Contrariwise, we see that cloth and apparel not aired, do breed moths and mould; and the diversity is, that in bodies that need detention of spirits, the exclusion of the air doth good; as in drinks and corn: but in bodies that need emission of spirits to discharge some of the superfluous moisture, it doth hurt, for they require airing.

344. The fourth is motion and stirring; for putrefaction asketh rest: for the subtle motion which putrefaction requireth, is disturbed by any agitation: and all local motion keepeth bodies integral, and their parts together; as we see that turning over of corn in a garner, or letting it run like an hour-glass, from an upper-room into a lower, doth keep it sweet:

and running waters putrify not; and in men's bodies, exercise hindereth putrefaction; and contrariwise, rest and want of motion, or stoppings, whereby the run of hnmours, or the motion of perspiration is stayed, further putrefaction; as we partly touched a little before.

345. The fifth is the breathing forth of the adventitious moisture in bodies; for as wetting doth hasten putrefaction, so convenient drying, whereby the more radical moisture is only kept in, putteth back putrefaction; so we see that herbs and flowers, if they be dried in the shade, or dried in the hot sun for a small time, keep best. For the emission of the loose and adventitious moisture doth betray the radical moisture, and carrieth it out for company.

346. The sixth is the strengthening of the spirits of bodies; for as a great heat keepeth bodies from putrefaction, but a tepid heat inclineth them to putrefaction; so a strong spirit likewise preserveth, and a weak or faint spirit disposeth to corruption. So we find that salt water corrupteth not so soon as fresh: and salting of oysters, and powdering of meat, keepeth them from putrefaction. It would be tried also whether chalk put into water, or drink, doth not preserve it from putrifying or speedy souring. So we see that strong beer will last longer than small; and all things that are hot and aromatical, do help to preserve liquors, or powders, &c. which they do as well by strengthening the spirits, as by soaking out the loose moisture.

347. The seventh is separation of the cruder

parts, and thereby making the body more equal; for all imperfect mixture is apt to putrify; and watery substances are more apt to putrify than oily. So we see distilled waters will last longer than raw waters; and things that have passed the fire do last longer than those that have not passed the fire, as dried pears, &c.

348. The eighth is the drawing forth continually of that part where the putrefaction beginneth; which is, commonly, the loose and watery moisture; not only for the reason before given, that it provoketh the radical moisture to come forth with it; but because being detained in the body, the putrefaction taking hold of it, infecteth the rest: as we see in the embalming dead bodies; and the same reason is of preserving herbs, or fruits, or flowers, in bran or meal.

349. The ninth is the commixture of any thing that is more oily or sweet: for such bodies are least apt to putrify, the air working little upon them, and they not putrifying, preserve the rest. And therefore we see syrups and ointments will last longer than juices.

350. The tenth is the commixture of somewhat that is dry; for putrefaction beginneth first from the spirits and then from the moisture: and that that is dry is unapt to putrify: and therefore smoke preserveth flesh; as we see in bacon and neats' tongues, and Martlemas beef, &c.

351. The opinion of some of the ancients, that blown airs do preserve bodies longer than other airs, seemeth to me probable; for that the blown airs,

being overcharged and compressed, will hardly receive the exhaling of any thing, but rather repulse it. It was tried in a blown bladder, whereinto flesh was put, and likewise a flower, and it sorted not: for dry bladders will not blow; and new bladders rather further putrefaction: the way were therefore to blow strongly with a pair of bellows into a hogshead, putting into the hogshead, before, that which you would have preserved; and in the instant that you withdraw the bellows, stop the hole close.

Experiment solitary touching wood shining in the dark.

352. The experiment of wood that shineth in the dark, we have diligently driven and pursued: the rather, for that of all things that give light here below, it is the most durable, and hath least apparent motion. Fire and flame are in continual expence; sugar shineth only while it is in scraping; and salt-water while it is in dashing; glow-worms have their shining while they live, or a little after; only scales of fishes putrified seem to be of the same nature with shining wood: and it is true, that all putrefaction hath with it an inward motion, as well as fire or light. The trial sorted thus: 1. The shining is in some pieces more bright, in some more dim; but the most bright of all doth not attain to the light of a glow-worm. 2. The woods that have been tried to shine, are chiefly sallow and willow; also the ash and hazle; it may be it holdeth in others. 3. Both root and bodies do shine, but the roots better.

4. The colour of the shining part, by day-light, is in some pieces white, in some pieces inclining to red; which in the country they call the white and red garret. 5. The part that shineth is, for the most part, somewhat soft, and moist to feel to, but some was found to be firm and hard, so as it might be figured into a cross, or into beads, &c. But you must not look to have an image, or the like, in any thing that is lightsome; for even a face in iron red-hot will not be seen, the light confounding the small differences of lightsome and darksome, which shew the figure. 6. There was the shining part pared off, till you came to that that did not shine; but within two days the part contiguous began also to shine, being laid abroad in the dew; so as it seemeth the putrefaction spreadeth. 7. There was other dead wood of like kind that was laid abroad, which shined not at the first; but after a night's lying abroad began to shine. 8. There was other wood that did first shine; and being laid dry in the house, within five or six days lost the shining; and laid abroad again, recovered the shining. 9. Shining woods being laid in a dry room, within a seven-night lose their shining; but being laid in a cellar, or dark room, keeps the shining. 10. The boring of holes in that kind of wood, and then laying it abroad, seemeth to conduce to make it shine: the cause is, for that all solution of continuity doth help on putrefaction, as was touched before. 11. No wood hath been yet tried to shine, that was cut down alive, but such as was rotted both in stock and root while it

grew. 12. Part of the wood that shined was steeped in oil, and retained the shining a fortnight. 13. The like succeeded in some steeped in water, and much better. 14. How long the shining will continue, if the wood be laid abroad every night, and taken in and sprinkled with water in the day, is not yet tried. 15. Trial was made of laying it abroad in frosty weather, which hurt it not. 16. There was a great piece of a root which did shine, and the shining part was cut off till no more shined; yet after two nights, though it were kept in a dry room, it got a shining.

Experiment solitary touching the acceleration of birth.

353. The bringing forth of living creatures may be accelerated in two respects: the one, if the embryo ripeneth and perfecteth sooner: the other, if there be some cause from the mother's body, of expulsion or putting it down: whereof the former is good, and argueth strength; the latter is ill, and cometh by accident or disease. And therefore the ancient observation is true, that the child born in the seventh month doth commonly well; but born in the eighth month, doth for the most part die. But the cause assigned is fabulous; which is, that in the eighth month should be the return of the reign of the planet Saturn, which as they say, is a planet malign; whereas in the seventh is the reign of the moon, which is a planet propitious. But the true cause is, for that where there is so great a preven-

tion of the ordinary time, it is the lustiness of the child; but when it is less, it is some indisposition of the mother.

Experiment solitary touching the acceleration of growth and stature.

354. To accelerate growth or stature, it must proceed either from the plenty of the nourishment, or from the nature of the nourishment, or from the quickening and exciting of the natural heat. For the first excess of nourishment is hurtful; for it maketh the child corpulent; and growing in breadth rather than in height. And you may take an experiment from plants, which if they spread much are seldom tall. As for the nature of the nourishment; first, it may not be too dry, and therefore children in dairy countries do wax more tall, than where they feed more upon bread and flesh. There is also a received tale, that boiling of daisy roots in milk, which it is certain are great driers, will make dogs little. But so much is true, that an over-dry nourishment in childhood putteth back stature. Secondly, the nourishment must be of an opening nature, for that attenuateth the juice, and furthereth the motion of the spirits upwards. Neither is it without cause, that Xenophon, in the nurture of the Persian children, doth so much commend their feeding upon cardamon, which, he saith, made them grow better, and be of a more active habit. Cardamon is in Latin "nasturtium," and with us water-cresses; which, it is certain, is an herb, that whilst it is young,

is friendly to life. As for the quickening of natural heat, it must be done chiefly with exercise; and therefore no doubt much going to school, where they sit so much, hindereth the growth of children; whereas country people that go not to school, are commonly of better stature. And again men must beware how they give children any thing that is cold in operation, for even long sucking doth hinder both wit and stature. This hath been tried, that a whelp that hath been fed with nitre in milk, hath become very little, but extreme lively: for the spirit of nitre is cold. And though it be an excellent medicine in strength of years for prolongation of life; yet it is in children and young creatures an enemy to growth: and all for the same reason, for heat is requisite to growth; but after a man is come to his middle age, heat consumeth the spirits, which the coldness of the spirit of nitre doth help to condense and correct.

Experiments in consort touching sulphur and mercury, two of Paracelsus's principles.

There be two great families of things, you may term them by several names; sulphureous and mercurial, which are the chemists' words, for as for their "sal," which is their third principle, it is a compound of the other two; inflammable and not inflammable; mature and crude, oily and watery. For we see that in subterranies there are, as the fathers of their tribes, brimstone and mercury; in vegetables and living creatures there is water and oil: in the inferior order of pneumaticals there is air

and flame, and in the superior there is the body of the star and the pure sky. And these pairs, though they be unlike in the primitive differences of matter, yet they seem to have many consents: for mercury and sulphur are principal materials of metals; water and oil are principal materials of vegetables and animals, and seem to differ but in maturation or concoction: flame, in vulgar opinion, is but air incensed; and they both have quickness of motion, and facility of cession, much alike: and the interstellar sky, though the opinion be vain, that the star is the denser part of his orb, hath notwithstanding so much affinity with the star, that there is a rotation of that, as well as of the star. Therefore it is one of the greatest "magnalia naturæ," to turn water or watery juice into oil or oily juice: greater in nature, than to turn silver or quicksilver into gold.

355. The instances we have wherein crude and watery substance turneth into fat and oily, are of four kinds. First in the mixture of earth and water; which mingled by the help of the sun gather a nitrous fatness, more than either of them have severally; as we see in that they put forth plants, which need both juices.

356. The second is in the assimilation of nourishment, made in the bodies of plants and living creatures, whereof plants turn the juice of mere water and earth into a great deal of oily matter: living creatures, though much of their fat and flesh are out of oily aliments, as meat and bread, yet they assimilate also in a measure their drink of water, &c.

But these two ways of version of water into oil, namely, by mixture and by assimilation, are by many passages and percolations, and by long continuance of soft heats, and by circuits of time.

357. The third is the inception of putrefaction; as in water corrupted; and the mothers of waters distilled; both which have a kind of fatness or oil.

358. The fourth is in the dulcoration of some metals, as " saccharum Saturni, &c."

359. The intention of version of water into a more oily substance is by digestion; for oil is almost nothing else but water digested, and this digestion is principally by heat, which heat must be either outward or inward: again, it may be by provocation or excitation, which is caused by the mingling of bodies already oily or digested; for they will somewhat communicate their nature with the rest. Digestion also is strongly effected by direct assimilation of bodies crude into bodies digested, as in plants and living creatures, whose nourishment is far more crude than their bodies: but this digestion is by a great compass, as hath been said. As for the more full handling of these two principles, whereof this is but a taste, the inquiry of which is one of the profoundest inquiries of nature, we leave it to the title of version of bodies, and likewise to the title of the first congregations of matter; which, like a general assembly of estates, doth give law to all bodies.

Experiment solitary touching chamelcons.

360. A chameleon is a creature about the bigness

of an ordinary lizard: his head unproportionably big: his eyes great: he moveth his head without the writhing of his neck, which is inflexible, as a hog doth: his back crooked; his skin spotted with little tumours, less eminent nearer the belly; his tail slender and long: on each foot he hath five fingers, three on the outside, and two on the inside; his tongue of a marvellous length in respect of his body, and hollow at the end; which he will launch out to prey upon flies. Of colour green, and of a dusky yellow, brighter and whiter towards the belly; yet spotted with blue, white, and red. If he be laid upon green, the green predominateth; if upon yellow, the yellow; not so if he be laid upon blue, or red, or white; only the green spots receive a more orient lustre; laid upon black he looketh all black, though not without a mixture of green. He feedeth not only upon air, though that be his principal sustenance, for sometimes he taketh flies, as was said, yet some that have kept chameleons a whole year together, could never perceive that ever they fed upon any thing else but air, and might observe their bellies to swell after they had exhausted the air, and closed their jaws; which they open commonly against the rays of the sun. They have a foolish tradition in magic, that if a chameleon be burnt upon the top of an house, it will raise a tempest; supposing, according to their vain dreams of sympathies, because he nourisheth with air, his body should have great virtue to make impression upon the air.

Experiment solitary touching subterrany fires.

364. It is reported by one of the ancients, that in part of Media there are eruptions of flames out of plains; and that those flames are clear, and cast not forth such smoke, and ashes, and pumice, as mountain flames do. The reason, no doubt, is, because the flame is not pent as it is in mountains and earthquakes which cast flame. There be also some blind fires under stone, which flame not out, but oil being poured upon them they flame out. The cause whereof is, for that it seemeth the fire is so choked, as not able to remove the stone, it is heat rather than flame, which nevertheless is sufficient to inflame the oil.

Experiment solitary touching nitre.

362. It is reported, that in some lakes the water is so nitrous, as, if foul clothes be put into it, it scoureth them of itself; and if they stay any whit long, they moulder away. And the scouring virtue of nitre is the more to be noted, because it is a body cold; and we see warm water scoureth better than cold. But the cause is, for that it hath a subtle spirit, which severeth and divideth any thing that is foul and viscous, and sticketh upon a body.

Experiment solitary touching congealing of air.

363. Take a bladder, the greatest you can get, fill it full of wind, and tie it about the neck with a silk thread waxed, and upon that put likewise wax

very close; so that when the neck of the bladder drieth, no air may possibly get in nor out. Then bury it three or four foot under the earth in a vault, or in a conservatory of snow, the snow being made hollow about the bladder, and after some fortnight's distance, see whether the bladder be shrunk; for if it be, then it is plain that the coldness of the earth or snow hath condensed the air, and brought it a degree nearer to water: which is an experiment of great consequence.

Experiment solitary touching congealing of water into crystal.

364. It is a report of some good credit, that in deep caves there are pensile crystals, and degrees of crystal that drop from above, and in some other, though more rarely, that rise from below: which though it be chiefly the work of cold, yet it may be that water that passeth through the earth, gathereth a nature more clammy, and fitter to congeal and become solid than water of itself. Therefore trial would be made, to lay a heap of earth, in great frosts, upon a hollow vessel, putting a canvas between, that it falleth not in: and pour water upon it, in such quantity as will be sure to soak through, and see whether it will not make an harder ice in the bottom of the vessel, and less apt to dissolve than ordinarily. I suppose also that if you make the earth narrower at the bottom than at the top, in fashion of a sugar-loaf reversed, it will help the experiment. For it will make the ice, where it issueth, less in bulk, and evermore smallness of quantity is a help to version.

Experiment solitary touching preserving of rose-leaves both in colour and smell.

365. Take damask roses, and pull them, then dry them upon the top of an house, upon a lead or terras, in the hot sun, in a clear day, between the hours only of twelve and two, or thereabouts. Then put them into a sweet dry earthen bottle, or a glass, with narrow mouths, stuffing them close together, but without bruising: stop the bottle or glass close, and these roses will retain not only their smell perfect, but their colour fresh, for a year at least. Note, that nothing doth so much destroy any plant, or other body, either by putrefaction or arefaction, as the adventitious moisture which hangeth loose in the body, if it be not drawn out. For it betrayeth and tolleth forth the innate and radical moisture along with it when itself goeth forth. And therefore in living creatures, moderate sweat doth preserve the juice of the body. Note, that these roses, when you take them from the drying, have little or no smell; so that the smell is a second smell, that issueth out of the flower afterwards.

Experiments in consort touching the continuance of flame.

366. The continuance of flame, according unto the diversity of the body inflamed, and other circumstances, is worthy the inquiry; chiefly, for that though flame be almost of a momentary lasting, yet it receiveth the more, and the less: we will first

therefore speak at large of bodies inflamed wholly and immediately, without any wick to help the inflammation. A spoonful of spirit of wine, a little heated, was taken, and it burnt as long as came to a hundred and sixteen pulses. The same quantity of spirit of wine mixed with the sixth part of a spoonful of nitre, burnt but to the space of ninety-four pulses. Mixed with the like quantity of bay-salt, eighty-three pulses. Mixed with the like quantity of gunpowder, which dissolved into a black water, one hundred and ten pulses. A cube or pellet of yellow wax was taken, as much as half the spirit of wine, and set in the midst, and it burnt only to the space of eighty-seven pulses. Mixed with the sixth part of a spoonful of milk, it burnt to the space of one hundred pulses; and the milk was curdled. Mixed with the sixth part of a spoonful of water, it burnt to the space of eighty-six pulses, with an equal quantity of water, only to the space of four pulses. A small pebble was laid in the midst, and the spirit of wine burnt to the space of ninety-four pulses. A piece of wood of the bigness of an arrow, and about a finger's length, was set up in the midst, and the spirit of wine burnt to the space of ninety-four pulses. So that the spirit of wine simple endured the longest; and the spirit of wine with the bay-salt, and the equal quantity of water, were the shortest.

387. Consider well, whether the more speedy going forth of the flame be caused by the greater vigour of the flame in burning, or by the resistance

of the body mixed, and the aversion thereof to take flame; which will appear by the quantity of the spirit of wine that remaineth after the going out of the flame. And it seemeth clearly to be the latter; for that the mixture of things least apt to burn, is the speediest in going out. And note, by the way, that spirit of wine burned, till it go out of itself, will burn no more: and tasteth nothing so hot in the mouth as it did; no, nor yet sour, as if it were a degree towards vinegar, which burnt wine doth; but flat and dead.

368. Note, that in the experiment of wax aforesaid, the wax dissolved in the burning, and yet did not incorporate itself with the spirit of wine to produce one flame; but wheresoever the wax floated, the flame forsook it, till at last it spread all over, and put the flame quite out.

369. The experiments of the mixtures of the spirit of wine inflamed, are things of discovery, and not of use: but now we will speak of the continuance of flames, such as are used for candles, lamps, or tapers; consisting of inflammable matters, and of a wick that provoketh inflammation. And this importeth not only discovery, but also use and profit; for it is a great saving in all such lights, if they can be made as fair and bright as others, and yet last longer. Wax pure made into a candle, and wax mixed severally into candle-stuff, with the particulars that follow, viz. water, aqua vitæ, milk, bay-salt, oil, butter, nitre, brimstone, saw-dust, every of these bearing a sixth part to the wax; and every of these candles mixed, being of the same weight and wick with the wax pure, proved thus in the burning

and lasting. The swiftest in consuming was that with saw-dust; which first burned fair till some part of the candle was consumed, and the dust gathered about the snaste; but then it made the snaste big and long, and to burn duskishly, and the candle wasted in half the time of the wax pure. The next in swiftness were the oil and butter, which consumed by a fifth part swifter than the pure wax. Then followed in swiftness the clear wax itself. Then the bay-salt, which lasted about an eighth part longer than the clear wax. Then followed the aqua vitæ, which lasted about a fifth part longer than the clear wax. Then followed the milk and water, with little difference from the aqua vitæ, but the water slowest. And in these four last, the wick would spit forth little sparks. For the nitre, it would not hold lighted above some twelve pulses, but all the while it would spit out portions of flame, which afterwards woald go out into a vapour. For the brimstone, it would hold lighted much about the same time with the nitre; but then after a little while it would harden and cake about the snaste; so that the mixture of bay-salt with wax will win an eighth part of the time of lasting, and the water a fifth.

370. After the several materials were tried, trial was likewise made of several wicks; as of ordinary cotton, sewing thread, rush, silk, straw, and wood. The silk, straw, and wood, would flame a little, till they came to the wax, and then go out: of the other three, the thread consumed faster than the cotton, by a sixth part of time: the cotton next; then the rush consumed slower than the cotton, by

at least a third part of time. For the bigness of the flame, the cotton and thread cast a flame much alike; and the rush much less and dimmer. *Query*, Whether wood and wicks both, as in torches, consume faster than the wicks simple.

371. We have spoken of the several materials, and the several wicks: but to the lasting of the flame it importeth also, not only what the material is, but in the same material whether it be hard, soft, old, new, &c. Good housewives, to make their candles burn the longer, use to lay them, one by one, in bran or flour, which make them harder, and so they consume the slower: insomuch as by this means they will outlast other candles of the same stuff almost half in half. For bran and flour have a virtue to harden; so that both age, and lying in the bran, doth help to the lasting. And we see that wax candles last longer than tallow candles, because wax is more firm and hard.

372. The lasting of flame also dependeth upon the easy drawing of the nourishment; as we see in the Court of England there is a service which they call Allnight; which is as it were a great cake of wax, with the wick in the midst; whereby it cometh to pass, that the wick fetcheth the nourishment farther off. We see also that lamps last longer, because the vessel is far broader than the breadth of a taper or candle.

373. Take a turreted lamp of tin, made in the form of a square: the height of the turret being thrice as much as the length of the lower part

whereupon the lamp standeth: make only one hole in it, at the end of the return farthest from the turret. Reverse it, and fill it full of oil by that hole; and then set it upright again; and put a wick in at the hole, and lighten it: you shall find that it will burn slow, and a long time: which is caused, as was said last before, for that the flame fetcheth the nourishment afar off. You shall find also, that as the oil wasteth and descendeth, so the top of the turret by little and little filleth with air; which is caused by the rarefaction of the oil by the heat. It were worthy the observation to make a hole in the top of the turret, and to try when the oil is almost consumed, whether the air made of the oil, if you put to it a flame of a candle, in the letting of it forth, will inflame. It were good also to have the lamp made, not of tin, but of glass, that you may see how the vapour or air gathereth by degrees in the top.

374. A fourth point that importeth the lasting of the flame, is the closeness of the air, wherein the flame burneth. We see that if wind bloweth upon a candle it wasteth apace. We see also it lasteth longer in a lanthorn than at large. And there are traditions of lamps and candles, that have burnt a very long time in caves and tombs.

375. A fifth point that importeth the lasting of the flame, is the nature of the air where the flame burneth; whether it be cold or hot, moist or dry. The air, if it be very cold, irritateth the flame, and maketh it burn more fiercely, as fire scorcheth in frosty weather, and so furthereth the consumption.

The air once heated, I conceive, maketh the flame burn more mildly, and so helpeth the continuance. The air, if it be dry, is indifferent: the air, if it be moist, doth in a degree quench the flame, as we see lights will go out in the damps of mines, and howsoever maketh it burn more dully, and so helpeth the continuance.

Experiments in consort touching burials or infusions of divers bodies in earth.

376. Burials in earth serve for preservation, and for condensation, and for induration of bodies. And if you intend condensation or induration, you may bury the bodies so as earth may touch them; as if you will make artificial porcelane, &c. And the like you may do for conservation, if the bodies be hard and solid; as clay, wood, &c. But if you intend preservation of bodies more soft and tender, then you must do one of these two: either you must put them in cases, whereby they may not touch the earth, or else you must vault the earth, whereby it may hang over them and not touch them: for if the earth touch them, it will do more hurt by the moisture, causing them to putrify, than good by the virtual cold, to conserve them, except the earth be very dry and sandy.

377. An orange, lemon, and apple, wrapt in a linen cloth, being buried for a fortnight's space four foot deep within the earth, though it were in a moist place, and a rainy time, yet came forth no ways mouldy or rotten, but were become a little harder

than they were; otherwise fresh in their colour; but their juice somewhat flatted. But with the burial of a fortnight more they became putrified.

378. A bottle of beer, buried in like manner as before, became more lively, better tasted, and clearer than it was. And a bottle of wine in like manner. A bottle of vinegar so buried came forth more lively and more odoriferous, smelling almost like a violet. And after the whole month's burial, all the three came forth as fresh and lively, if not better than before.

379. It were a profitable experiment to preserve oranges, lemons, and pomegranates, till summer: for then their price will be mightily increased. This may be done, if you put them in a pot or vessel well covered, that the moisture of the earth come not at them; or else by putting them in a conservatory of snow. And generally, whosoever will make experiments of cold, let him be provided of three things; a conservatory of snow; a good large vault, twenty foot at least under the ground; and a deep well.

380. There hath been a tradition, that pearl, and coral, and turquois-stone, that have lost their colours, may be recovered by burying in the earth; which is a thing of great profit, if it would sort: but upon trial of six weeks burial, there followed no effect. It were good to try it in a deep well, or in a conservatory of snow; where the cold may be more constringent; and so make the body more united, and thereby more resplendent.

Experiment solitary touching the effects in men's bodies from several winds.

381. Men's bodies are heavier, and less disposed to motion, when southern winds blow than when northern. The cause is, for that when the southern winds blow, the humours do, in some degree, melt and wax fluid, and so flow into the parts; as it is seen in wood and other bodies, which, when the southern winds blow, do swell. Besides, the motion and activity of the body consisteth chiefly in the sinews, which, when the southern wind bloweth, are more relax.

Experiments solitary touching winter and summer sicknesses.

382. It is commonly seen, that more are sick in the summer, and more die in the winter; except it be in pestilent diseases, which commonly reign in summer or autumn. The reason is, because diseases are bred, indeed, chiefly by heat; but then they are cured most by sweat and purge; which in the summer cometh on or is provoked more easily. As for pestilent diseases, the reason why most die of them in summer is, because they are bred most in the summer; for otherwise those that are touched are in most danger in the winter.

Experiment solitary touching pestilential seasons.

313. The general opinion is, that years hot and moist are most pestilent; upon the superficial ground

that heat and moisture cause putrefaction. In England it is found not true; for many times there have been great plagues in dry years. Whereof the cause may be, for that drought in the bodies of islanders habituate to moist airs, doth exasperate the humours, and maketh them more apt to putrify or inflame: besides, it tainteth the waters, commonly, and maketh them less wholesome. And again in Barbary, the plagues break up in the summer months, when the weather is hot and dry.

Experiment solitary touching an error received about epidemical diseases,

384. Many diseases, both epidemical and others, break forth at particular times. And the cause is falsely imputed to the constitution of the air at that time when they break forth or reign; whereas it proceedeth, indeed, from a precedent sequence and series of the seasons of the year: and therefore Hippocrates in his prognostics doth make good observations of the diseases that ensue upon the nature of the precedent four seasons of the year.

Experiment solitary touching the alteration or preservation of liquors in wells or deep vaults.

385. Trial hath been made with earthen bottles well stopped, hanged in a well of twenty fathom deep at the least, and some of the bottles have been let down into the water, some others have hanged above, within about a fathom of the water; and the liquors so tried have been beer, not new, but ready

for drinking, and wine, and milk. The proof hath been, that both the beer and the wine, as well within the water as above, hath not been palled or deaded at all; but as good or somewhat better than bottles of the same drinks and staleness kept in a cellar. But those which did hang above water were apparently the best; and that beer did flower a little; whereas that under water did not, though it were fresh. The milk soured and began to putrify. Nevertheless it is true, that there is a village near Blois, where in deep caves they do thicken milk, in such sort that it becometh very pleasant: which was some cause of this trial of hanging milk in the well: but our proof was naught; neither do I know whether that milk in those caves be first boiled. It were good therefore to try it with milk sodden, and with cream; for that milk of itself is such a compound body, of cream, curds, and whey, as it is easily turned and dissolved. It were good also to try the beer when it is in wort, that it may be seen whether the hanging in the well will accelerate the ripening and clarifying of it.

Experiment solitary touching stutting.

386. Divers, we see, do stut. The cause may be, in most the refrigeration of the tongue; whereby it is less apt to move. And therefore we see that naturals do generally stut: and we see that in those that stut, if they drink wine moderately, they stut less, because it heateth: and so we see, that they that stut do stut more in the first offer to speak than

in continuance; because the tongue is by motion somewhat heated. In some also, it may be, though rarely, the dryness of the tongue, which likewise maketh it less apt to move as well as cold: for it is an affect that cometh to some wise and great men; as it did unto Moses, who was "linguæ præpeditæ;" and many stutters, we find, are very choleric men: choler inducing a dryness in the tongue.

Experiments in consort touching smells.

387. Smells and other odours are sweeter in the air at some distance, than near the nose; as hath been partly touched heretofore. The cause is double: first, the finer mixture or incorporation of the smell: for we see that in sounds likewise, they are sweetest when we cannot hear every part by itself. The other reason is, for that all sweet smells have joined with them some earthly or crude odours; and at some distance the sweet, which is the more spiritual, is perceived, and the earthy reacheth not so far.

388. Sweet smells are most forcible in dry substances when they are broken; and so likewise in oranges or lemons, the nipping of their rind giveth out their smell more: and generally when bodies are moved or stirred, though not broken, they smell more, as a sweet-bag waved. The cause is double: the one, for that there is a greater emission of the spirit when way is made; and this holdeth in the breaking, nipping, or crushing; it holdeth also, in some degree, in the moving: but in this last there is

a concurrence of the second cause, which is the impulsion of the air that bringeth the scent faster upon us.

389. The daintiest smells of flowers are out of those plants whose leaves smell not; as violets, roses, wall-flowers, gilly-flowers, pinks, woodbines, vine-flowers, apple-blooms, limetree-blooms, bean-blooms, &c. The cause is, for that where there is heat and and strength enough in the plant to make the leaves odorate, there the smell of the flower is rather evanid and weaker than that of the leaves; as it is in rose-mary flowers, lavender flowers, and sweet-briar roses. But where there is less heat, there the spirit of the plant is digested and refined, and severed from the grosser juice, in the efflorescence, and not before.

390. Most odours smell best broken or crushed, as hath been said: but flowers pressed or beaten do lose the freshness and sweetness of their odour. The cause is, for that when they are crushed, the grosser and more earthy spirit cometh out with the finer, and troubleth it; whereas in stronger odours there are no such degrees of the issue of the smell.

Experiments in consort touching the goodness and choice of water.

391. It is a thing of very good use to discover the goodness of waters. The taste, to those that drink water only, doth somewhat: but other experiments are more sure. First, try waters by weight,

wherein you may find some difference, though not much; and the lighter you may account the better.

392. Secondly, try them by boiling upon an equal fire; and that which consumeth away fastest, you may account the best.

393. Thirdly, try them in several bottles or open vessels, matches in every thing else, and see which of them last longest without stench or corruption. And that which holdeth unputrified longest, you may likewise account the best.

394. Fourthly, try them by making drinks stronger or smaller, with the same quantity of malt; and you may conclude, that that water which maketh the stronger drink, is the more concocted and nourishing; though perhaps it be not so good for medicinal use. And such water, commonly, is the water of large and navigable rivers; and likewise in large and clean ponds of standing water; for upon both them the sun hath more power than upon fountains or small rivers. And I conceive that chalk-water is next them the best for going furthest in drink: for that also helpeth concoction; so it be out of a deep well, for then it cureth the rawness of the water; but chalky water, towards the top of the earth, is too fretting; as it appeareth in laundry of clothes, which wear out apace if you use such waters.

395. Fifthly, the housewives do find a difference in waters, for the bearing or not bearing of soap: and it is likely that the more fat water will bear soap best; for the hungry water doth kill the unctuous nature of the soap.

396. Sixthly, you may make a judgment of

waters according to the place whence they spring or come: the rain-water is, by the physicians, esteemed the finest and the best; but yet it is said to putrify soonest, which is likely, because of the fineness of the spirit: and in conservatories of rain-water, such as they have in Venice, &c. they are found not so choice waters; the worse, perhaps, because they are covered aloft, and kept from the sun. Snow-water is held unwholesome; insomuch as the people that dwell at the foot of the snow mountains, or otherwise upon the ascent, especially the women, by drinking of snow-water, have great bags hanging under their throats. Well-water, except it be upon chalk, or a very plentiful spring, maketh meat red; which is an ill sign. Springs on the tops of high hills are the best: for both they seem to have a lightness and appetite of mounting; and besides, they are most pure and unmingled; and again, are more percolated through a great space of earth. For waters in valleys join in effect under ground with all waters of the same level; whereas springs on the tops of hills pass through a great deal of pure earth with less mixture of other waters.

397. Seventhly, judgment may be made of waters by the soil whereupon the water runneth; as pebble is the cleanest and best tasted; and next to that, clay-water; and thirdly, water upon chalk; fourthly, that upon sand; and worst of all upon mud. Neither may you trust waters that taste sweet, for they are commonly found in rising grounds

of great cities, which must needs take in a great deal of filth.

Experiment solitary touching the temperate heat under the equinoctial.

398. In Peru, and divers parts of the West Indies, though under the line, the heats are not so intolerable as they be in Barbary, and the skirts of the torrid zone. The causes are, first the great breezes which the motion of the air in great circles, such as are under the girdle of the world, produceth, which do refrigerate; and therefore in those parts noon is nothing so hot, when the breezes are great, as about nine or ten of the clock in the forenoon. Another cause is, for that the length of the night, and the dews thereof, do compensate the heat of the day. A third cause is, the stay of the sun; not in respect of day and night, for that we spake of before, but in respect of the season; for under the line the sun crosseth the line, and maketh two summers and two winters, but in the skirts of the torrid zone it doubleth and goeth back again, and so maketh one long summer.

Experiment solitary touching the coloration of black and tawny Moors.

399. The heat of the sun maketh men black in some countries, as in Æthiopia and Guiney, &c. Fire doth it not, as we see in glass-men, that are continually about the fire. The reason may be,

because fire doth lick up the spirits and blood of the body, so as they exhale, so that it ever maketh men look pale and sallow; but the sun, which is a gentler heat, doth but draw the blood to the outward parts, and rather concocteth it than soaketh it; and therefore we see that all Æthiopes are fleshy and plump, and have great lips, all which betoken moisture retained, and not drawn out. We see also, that the Negroes are bred in countries that have plenty of water, by rivers and otherwise; for Meroë, which was the metropolis of Æthiopia, was upon a great lake; and Congo, where the Negroes are, is full of rivers. And the confines of the river Niger, where the Negroes also are, are well watered: and the region above Cape Verde is likewise moist, insomuch as it is pestilent through moisture: but the countries of the Abyssenes, and Barbary, and Peru, where they are tawny, and olivaster, and pale, are generally more sandy and dry. As for the Æthiopes, as they are plump and fleshy, so, it may be, they are sanguine and ruddy coloured, if their black skin would suffer it to be seen.

Experiment solitary touching motion after the instant of death.

400. Some creatures do move a good while after their head is off, as birds; some a very little time, as men and all beasts; some move, though cut in several pieces, as snakes, eels, worms, flies, &c. First, therefore, it is certain, that the immediate

cause of death is the resolution or extinguishment of the spirits; and that the destruction or corruption of the organs is but the mediate cause. But some organs are so peremptorily necessary, that the extinguishment of the spirits doth speedily follow; but yet so as there is an interim of a small time. It is reported by one of the ancients of credit, that a sacrificed beast hath lowed after the heart hath been severed; and it is a report also of credit, that the head of a pig hath been opened, and the brain put into the palm of a man's hand, trembling, without breaking any part of it, or severing it from the marrow of the back-bone, during which time the pig hath been, in all appearance, stark dead, and without motion; and after a small time the brain hath been replaced, and the skull of the pig closed, and the pig hath a little after gone about. And certain it is, that an eye, upon revenge, hath been thrust forth, so as it hanged a pretty distance by the visual nerve; and during that time the eye hath been without any power of sight; and yet after being replaced recovered sight. Now the spirits are chiefly in the head and cells of the brain, which in men and beasts are large; and therefore, when the head is off, they move little or nothing. But birds have small heads, and therefore the spirits are a little more dispersed in the sinews, whereby motion remaineth in them a little longer; insomuch, as it is extant in story, that an emperor of Rome, to shew the certainty of his hand, did shoot a great forked

arrow at an ostrich, as she ran swiftly upon the stage, and struck off her head, and yet she continued the race a little way with the head off. As for worms, and flies, and eels, the spirits are diffused almost all over, and therefore they move in their several pieces.

NATURAL HISTORY.

CENTURY V.

Experiments in consort touching the acceleration of germination.

We will now inquire of plants or vegetables, and we shall do it with diligence. They are the principal part of the third day's work. They are the first "producat," which is the word of animation: for the other words are but the words of essence. And they are of excellent and general use for food, medicine, and a number of mechanical arts.

401. There were sown in a bed, turnip-seed, radish-seed, wheat, cucumber-seed, and peas. The bed we call a hot-bed, and the manner of it is this: there was taken horse-dung, old and well rotted; this was laid upon a bank half a foot high, and supported round about with planks; and upon the top was cast sifted earth, some two fingers deep, and then the seed sprinkled upon it, having been steeped all night in water mixed with cow-dung. The turnip-seed and the wheat came up half an inch above ground within two days after, without any watering. The rest the third day. The experiment was made in October; and, it may be, in the spring,

the accelerating would have been the speedier. This is a noble experiment; for without this help they would have been four times as long in coming up. But there doth not occur to me, at this present, any use thereof for profit, except it should be for sowing of peas, which have their price very much increased by the early coming. It may be tried also with cherries, strawberries, and other fruit, which are dearest when they come early.

402. There was wheat steeped in water mixed with cow-dung; other in water mixed with horse-dung; other in water mixed with pigeon-dung; other in urine of man, other in water mixed with chalk powdered, other in water mixed with soot, other in water mixed with ashes, other in water mixed with bay-salt, other in claret wine, other in malmsey, other in spirit of wine. The proportion of the mixture was a fourth part of the ingredients to the water; save that there was not of the salt above an eighth part. The urine, and wines, and spirit of wine, were simple without mixture of water. The time of the steeping was twelve hours. The time of the year October. There was also other wheat sown unsteeped, but watered twice a day with warm water. There was also other wheat sown simple, to compare it with the rest. The event was, that those that were in the mixture of dung, and urine, and soot, chalk, ashes, and salt, came up within six days; and those that afterwards proved the highest, thickest, and most lusty, were first the urine, and then the dungs, next the chalk, next the soot, next the

ashes, next the salt, next the wheat simple of itself, unsteeped and unwatered, next the watered twice a day with warm water, next the claret wine. So that these three last were slower than the ordinary wheat of itself, and this culture did rather retard than advance. As for those that were steeped in malmsey, and spirit of wine, they came not up at all. This is a rich experiment for profit; for the most of the steepings are cheap things, and the goodness of the crop is a great matter of gain, if the goodness of the crop answer the earliness of the coming up, as it is like it will, both being from the vigour of the seed, which also partly appeared in the former experiments, as hath been said. This experiment would be tried in other grains, seeds, and kernels: for it may be some steeping will agree best with some seeds. It would be tried also with roots steeped as before, but for longer time. It would be tried also in several seasons of the year, especially the spring.

403. Strawberries watered now and then, as once in three days, with water wherein hath been steeped sheeps-dung or pigeons-dung, will prevent and come early. And it is like the same effect would follow in other berries, herbs, flowers, grains, or trees. And therefore it is an experiment, though vulgar in strawberries, yet not brought into use generally: for it is usual to help the ground with muck, and likewise to recomfort it sometimes with muck put to the roots; but to water it with muck water, which is like to be more forcible, is not practised.

404. Dung, or chalk, or blood, applied in sub-

stance, seasonably, to the roots of trees, doth set them forwards. But to do it unto herbs, without mixture of water or earth, it may be these helps are too hot.

405. The former means of helping germination, are either by the goodness and strength of the nourishment, or by the comforting and exciting the spirits in the plant, to draw the nourishment better. And of this latter kind, concerning the comforting of the spirits of the plant, are also the experiments that follow; though they be not applications to the root or seed. The planting of trees warm upon a wall against the south, or south-east sun, doth hasten their coming on and ripening; and the south-east is found to be better than the south-west, though the south-west be the hotter coast. But the cause is chiefly, for that the heat of the morning succeedeth the cold of the night: and partly, because many times the south-west sun is too parching. So likewise the planting of them upon the back of a chimney where a fire is kept, doth hasten their coming on and ripening; nay more, the drawing of the boughs into the inside of a room where a fire is continually kept, worketh the same effect, which hath been tried with grapes, insomuch as they will come a month earlier than the grapes abroad.

406. Besides the two means of accelerating germination formerly described; that is to say, the mending of the nourishment; and comforting of the spirit of the plant; there is a third, which is the making way for the easy coming to the nourishment,

and drawing it. And therefore gentle digging and loosening of the earth about the roots of trees: and the removing herbs and flowers into new earth once in two years, which is the same thing, for the new earth is ever looser, doth greatly further the prospering and earliness of plants.

407. But the most admirable acceleration by facilitating the nourishment is that of water. For a standard of a damask rose with the root on, was set in a chamber where no fire was, upright in an earthen pan, full of fair water, without any mixture, half a foot under the water, the standard being more than two foot high above the water: within the space of ten days the standard did put forth a fair green leaf, and some other little buds, which stood at a stay, without any shew of decay or withering, more than seven days. But afterwards that leaf faded, but the young buds did sprout on, which afterward opened into fair leaves in the space of three months, and continued so a while after, till upon removal we left the trial. But note, that the leaves were somewhat paler and lighter-coloured than the leaves used to be abroad. Note, that the first buds were in the end of October; and it is likely that if it had been in the spring time, it would have put forth with greater strength, and, it may be, to have grown on to bear flowers. By this means you may have, as it seemeth, roses set in the midst of a pool, being supported with some stay; which is matter of rareness and pleasure, though of small use. This is the more strange, for that the like rose-standard was put at

the same time into water mixed with horse-dung, the horse-dung about the fourth part to the water, and in four months' space, while it was observed, put not forth any leaf, though divers buds at the first, as the other.

408. A Dutch flower that had a bulbous root, was likewise put at the same time all under water, some two or three fingers deep, and within seven days sprouted, and continued long after further growing. There were also put in, a beet-root, a borage root, and a radish-root, which had all their leaves cut almost close to the roots, and within six weeks had fair leaves, and so continued till the end of November.

409. Note, that if roots, or peas, or flowers, may be accelerated in their coming and ripening, there is a double profit; the one in the high price that those things bear when they come early: the other in the swiftness of their returns: for in some grounds which are strong, you shall have a radish, &c. come in a month, that in other grounds will not come in two, and so make double returns.

410. Wheat also was put into the water, and came not forth at all; so as it seemeth there must be some strength and bulk in the body put into the water, as it is in roots, for grains, or seeds, the cold of the water will mortify. But casually some wheat lay under the pan, which was somewhat moistened by the suing of the pan; which in six weeks, as aforesaid, looked mouldy to the eye, but it was sprouted forth half a finger's length.

411. It seemeth by these instances of water, that for nourishment the water is almost all in all, and that the earth doth but keep the plant upright, and save it from over-heat and over-cold; and therefore is a comfortable experiment for good drinkers. It proveth also that our former opinion, that drink incorporate with flesh or roots, as in capon-beer, &c. will nourish more easily, than meat and drink taken severally.

412. The housing of plants, I conceive, will both accelerate germination, and bring forth flowers and plants in the colder seasons: and as we house hot-country plants, as lemons, oranges, myrtles, to save them; so we may house our own country plants, to forward them, and make them come in the cold seasons; in such sort, that you may have violets, strawberries, peas, all winter: so that you sow or remove them at fit times. This experiment is to be referred unto the comforting of the spirit of the plant by warmth, as well as housing their boughs, &c. So then the means to accelerate germination, are in particular eight, in general three.

Experiments in consort touching the putting back or retardation of germination.

413. To make roses, or other flowers come late, it is an experiment of pleasure. For the ancients esteemed much of "rosa sera." And indeed the November rose is the sweetest, having been less exhaled by the sun. The means are these. First, the cutting off their tops immediately after they have

done bearing, and then they will come again the same year about November: but they will not come just on the tops where they were cut, but out of those shoots which were, as it were, water boughs. The cause is, for that the sap, which otherwise would have fed the top, though after bearing, will, by the discharge of that, divert unto the side sprouts, and they will come to bear, but later.

414. The second is the pulling off the buds of the rose, when they are newly knotted; for then the side branches will bear. The cause is the same with the former; for cutting off the tops, and pulling off the buds, work the same effect, in retention of the sap for a time, and diversion of it to the sprouts that were not so forward.

415. The third is the cutting off some few of the top boughs in the spring time, but suffering the lower boughs to grow on. The cause is, for that the boughs do help to draw up the sap more strongly; and we see that in polling of trees, many do use to leave a bough or two on the top, to help to draw up the sap. And it is reported also, that if you graft upon the bough of a tree, and cut off some of the old boughs, the new cions will perish.

416. The fourth is by laying the roots bare about Christmas some days. The cause is plain, for that it doth arrest the sap from going upwards for a time; which arrest is afterwards released by the covering of the root again with earth; and then the sap getteth up but later.

417. The fifth is the removing of the tree some month before it buddeth. The cause is, for that some time will be required after the remove for the re-settling, before it can draw the juice; and that time being lost, the blossom must needs come forth later.

418. The sixth is the grafting of roses in May, which commonly gardeners do not till July; and then they bear not till the next year; but if you graft them in May, they will bear the same year, but late.

419. The seventh is the girding of the body of the tree about with some pack-thread; for that also in a degree restraineth the sap, and make it come up more late and more slowly.

420. The eighth is the planting of them in a shade, or in a hedge; the cause is, partly the keeping out of the sun, which hasteneth the sap to rise; and partly the robbing of them of nourishment by the stuff in the hedge. These means may be practised upon other, both trees and flowers, "mutatis mutandis."

421. Men have entertained a conceit that sheweth prettily; namely, that if you graft a late-coming fruit upon a stock of a fruit-tree that cometh early, the graft will bear fruit early; as a peach upon a cherry; and contrariwise, if an early-coming fruit upon a stock of a fruit-tree that cometh late, the graft will bear fruit late, as a cherry upon a peach. But these are but imaginations, and untrue. The

cause is, for that the cion over-ruleth the stock quite, and the stock is but passive only, and giveth aliment, but no motion to the graft.

Experiments in consort touching the melioration of fruits, trees, and plants.

We will speak now, how to make fruits, flowers, and roots larger, in more plenty, and sweeter than they use to be, and how to make the trees themselves more tall, more spread, and more hasty and sudden than they use to be. Wherein there is no doubt but the former experiments of acceleration will serve much to these purposes. And again, that these experiments, which we shall now set down, do serve also for acceleration, because both effects proceed from the increase of vigour in the tree; but yet to avoid confusion, and because some of the means are more proper for the one effect, and some for the other, we will handle them apart.

422. It is an assured experience, that an heap of flint or stone, laid about the bottom of a wild tree, as an oak, elm, ash, &c. upon the first planting, doth make it prosper double as much as without it. The cause is, for that it retaineth the moisture which falleth at any time upon the tree, and suffereth it not to be exhaled by the sun. Again, it keepeth the tree warm from cold blasts and frosts, as it were in an house. It may be also there is somewhat in the keeping of it steady at the first. Query, If laying of straw some height about the body of a tree, will not make the tree forwards. For though the root

giveth the sap, yet it is the body that draweth it. But you must note, that if you lay stones about the stalk of lettuce, or other plants that are more soft, it will over-moisten the roots, so as the worms will eat them.

423. A tree, at the first setting, should not be shaken, until it hath taken root fully: and therefore some have put two little forks about the bottom of their trees to keep them upright; but after a year's rooting, then shaking doth the tree good, by loosening of the earth, and, perhaps, by exercising, as it were, and stirring the sap of the tree.

424. Generally the cutting away of boughs and suckers at the root and body doth make trees grow high; and contrariwise, the polling and cutting of the top maketh them grow spread and bushy. As we see in pollards, &c.

425. It is reported, that to make hasty-growing coppice woods, the way is, to take willow, sallow, poplar, alder, of some seven years' growth; and to set them, not upright, but aslope, a reasonable depth under the ground; and then instead of one root they will put forth many, and so carry more shoots upon a stem.

426. When you would have many new roots of fruit trees, take a low tree and bow it, and lay all his branches aflat upon the ground, and cast earth upon them, and every twig will take root. And this is a very profitable experiment for costly trees, for the boughs will make stocks without charge; such as are apricots, peaches, almonds, cornelians, mulberries,

figs, &c. The like is continually practised with vines, roses, musk-roses, &c.

427. From May to July you may take off the bark of any bough, being of the bigness of three or four inches, and cover the bare place, somewhat above and below, with loam well tempered with horse-dung, binding it fast down. Then cut off the bough about Allallontide in the bare place, and set it in the ground, and it will grow to be a fair tree in one year. The cause may be, for that the baring from the bark keepeth the sap from descending towards winter, and so holdeth it in the bough; and it may be also that the loam and horse-dung applied to the bare place do moisten it, and cherish it, and make it more apt to put forth the root. Note, that this may be a general means for keeping up the sap of trees in their boughs, which may serve to other effects.

428. It hath been practised in trees that shew fair and bear not, to bore a hole through the heart of the tree, and thereupon it will bear. Which may be, for that the tree before had too much repletion, and was oppressed with its own sap; for repletion is an enemy to generation.

429. It hath been practised in trees that do not bear, to cleave two or three of the chief roots, and to put into the cleft a small pebble, which may keep it open, and then it will bear. The cause may be, for that a root of a tree may be, as it were, hide-bound, no less than the body of the tree; but it will not keep open without somewhat put into it.

430. It is usually practised, to set trees that require much sun upon walls against the south; as apricots, peaches, plums, vines, figs, and the like. It hath a double commodity; the one, the heat of the wall by reflexion; the other, the taking away of the shade; for when a tree groweth round, the upper boughs over-shadow the lower: but when it is spread upon a wall, the sun cometh alike upon the upper and lower branches.

431. It hath also been practised by some, to pull off some leaves from the trees so spread, that the sun may come upon the bough and fruit the better. There hath been practised also a curiosity, to set a tree upon the north side of a wall, and at a little height to draw it through the wall, and spread it upon the south side: conceiving that the root and lower part of the stock should enjoy the freshness of the shade; and the upper boughs, and fruit, the comfort of the sun. But it sorted not; the cause is, for that the root requireth some comfort from the sun, though under earth, as well as the body: and the lower part of the body more than the upper, as we see in compassing a tree below with straw.

432. The lowness of the bough where the fruit cometh, maketh the fruit greater, and to ripen better; for you shall ever see, in apricots, peaches, or melocotones upon a wall, the greatest fruits towards the bottom. And in France, the grapes that make the wine, grow upon low vines bound to small stakes; and the raised vines in arbours make but verjuice. It is true, that in Italy and other

countries where they have hotter sun, they raise them upon elms and trees; but I conceive, that if the French manner of planting low were brought in use there, their wines would be stronger and sweeter. But it is more chargeable in respect of the props. It were good to try whether a tree grafted somewhat near the ground, and the lower boughs only maintained, and the higher continually pruned off, would not make a larger fruit.

433. To have fruit in greater plenty, the way is to graft not only upon young stocks, but upon divers boughs of an old tree; for they will bear great numbers of fruit: whereas if you graft but upon one stock the tree can bear but few.

434. The digging yearly about the roots of trees, which is a great means both to the acceleration and melioration of fruits, is practised in nothing but in vines: which if it were transferred unto other trees and shrubs, as roses, &c. I conceive would advance them likewise.

435. It hath been known, that a fruit-tree hath been blown up almost by the roots, and set up again, and the next year bear exceedingly. The cause this was nothing but the loosening of the earth, which comforteth any tree, and is fit to be practised more than it is in fruit-trees: for trees cannot be so fitly removed into new grounds, as flowers and herbs may.

436. To revive an old tree, the digging of it about the roots, and applying new mould to the roots, is the way. We see also that draught-oxen

put into fresh pasture gather new and tender flesh; and in all things better nourishment than hath been used doth help to renew; especially if it be not only better, but changed and differing from the former.

437. If an herb be cut off from the roots in the beginning of winter, and then the earth be trodden and beaten down hard with the foot and spade, the roots will become of very great magnitude in summer. The reason is, for that the moisture being forbidden to come up in the plant, stayeth longer in the root, and so dilateth it. And gardeners use to tread down any loose ground after they have sown onions, or turnips, &c.

438. If "panicum" be laid below and about the bottom of a root, it will cause the root to grow to an excessive bigness. The cause is, for that being itself of a spongy substance, it draweth the moisture of the earth to it, and so feedeth the root. This is of greatest use for onions, turnips, parsnips, and carrots.

439. The shifting of ground is a means to better the tree and fruit; but with this caution, that all things do prosper best when they are advanced to the better; your nursery of stocks ought to be in a more barren ground than the ground is whereunto you remove them. So all graziers prefer their cattle from meaner pastures to better. We see also, that hardness in youth lengtheneth life, because it leaveth a cherishing to the better of the body in age: nay, in exercises, it is good to begin with the hardest, as dancing in thick shoes, &c.

440. It hath been observed, that hacking of trees in their bark, both downright and across, so as you may make them rather in slices than in continued hacks, doth great good to trees; and especially delivereth them from being hide-bound, and killeth their moss.

441. Shade to some plants conduceth to make them large and prosperous more than sun, as in strawberries and bays, &c. Therefore amongst strawberries sow here and there some borage seed, and you shall find the strawberries under those leaves far more large than their fellows. And bays you must plant to the north, or defend them from the sun by a hedge-row; and when you sow the berries, weed not the borders for the first half year; for the weed giveth them shade.

442. To increase the crops of plants, there would be considered not only the increasing the lust of the earth, or of the plant, but the saving also of that which is spilt. So they have lately made a trial to set wheat, which nevertheless hath been left off, because of the trouble and pains: yet so much is true, that there is much saved by the setting, in comparison of that which is sown, both by keeping it from being picked up by birds, and by avoiding the shallow lying of it, whereby much that is sown taketh no root.

443. It is prescribed by some of the ancients, that you take small trees, upon which figs or other fruit grow, being yet unripe, and cover the trees in the middle of autumn with dung until the spring;

and then take them up in a warm day, and replant them in good ground; and by that means the former year's tree will be ripe, as by a new birth, when other trees of the same kind do but blossom. But this seemeth to have no great probability.

444. It is reported, that if you take nitre, and mingle it with water, to the thickness of honey, and therewith anoint the bud after the vine is cut, it will sprout forth within eight days. The cause is like to be, if the experiment be true, the opening of the bud and of the parts contiguous, by the spirit of the nitre; for nitre is, as it were, the life of vegetables.

445. Take seed, or kernels of apples, pears, oranges; or a peach, or a plum-stone, &c. and put them into a squill, which is like a great onion, and they will come up much earlier than in the earth itself. This I conceive to be as a kind of grafting in the root; for as the stock of a graft yieldeth better prepared nourishment to the graft than the crude earth, so the squill doth the like to the seed. And I suppose the same would be done by putting kernels into a turnip or the like, save that the squill is more vigorous and hot. It may be tried also, with putting onion-seed into an onion-head, which thereby, perhaps, will bring forth a larger and earlier onion.

446. The pricking of a fruit in several places, when it is almost at its bigness, and before it ripeneth, hath been practised with success, to ripen the fruit more suddenly. We see the example of the

biting of wasps or worms upon fruit, whereby it manifestly ripeneth the sooner.

447. It is reported, that "alga marina," sea-weed, put under the roots of coleworts, and, perhaps, of other plants, will further their growth. The virtue, no doubt, hath relation to salt, which is a great help to fertility.

448. It hath been practised, to cut off the stalks of cucumbers, immediately after their bearing, close by the earth; and then to cast a pretty quantity of earth upon the plant that remaineth, and they will bear the next year fruit long before the ordinary time. The cause may be, for that the sap goeth down the sooner, and is not spent in the stalk or leaf, which remaineth after the fruit. Where note, that the dying in the winter of the roots of plants that are annual, seemeth to be partly caused by the over-expence of the sap into stalk and leaves; which being prevented, they will super-annuate, if they stand warm.

449. The pulling off many of the blossoms from a fruit-tree doth make the fruit fairer. The cause is manifest; for that the sap hath the less to nourish. And it is a common experience, that if you do not pull off some blossoms the first time a tree bloometh, it will blossom itself to death.

450. It were good to try what would be the effect, if all the blossoms were pulled from a fruit-tree: or the acorns and chestnut-buds, &c. from a wild tree, for two years together. I suppose that the tree will either put forth the third year bigger

and more plentiful fruit; or else, the same years, larger leaves, because of the sap stored up.

451. It hath been generally received, that a plant watered with warm water, will come up sooner and better than with cold water or with showers. But our experiment of watering wheat with warm water, as hath been said, succeeded not; which may be, because the trial was too late in the year, viz. in the end of October. For the cold then coming upon the seed, after it was made more tender by the warm water, might check it.

452. There is no doubt, but that grafting, for the most part, doth meliorate the fruit. The cause is manifest; for that the nourishment is better prepared in the stock than in the crude earth; but yet note well, that there be some trees that are said to come up more happily from the kernel than from the graft, as the peach and melocotone. The cause, I suppose to be, for that those plants require a nourishment of great moisture; and though the nourishment of the stock be finer and better prepared, yet it is not so moist and plentiful as the nourishment of the earth. And indeed we see those fruits are very cold fruits in their nature.

453. It hath been received, that a smaller pear grafted upon a stock that beareth a greater pear, will become great. But I think it is as true as that of the prime fruit upon the late stock; and "e con-"verso," which we rejected before; for the cion will govern. Nevertheless, it is probable enough, that if you can get a cion to grow upon a stock of another

kind, that is much moister than its own stock, it may make the fruit greater, because it will yield more plentiful nourishment, though it is like it will make the fruit baser. But generally the grafting is upon a drier stock, as the apple upon a crab, the pear upon a thorn, &c. Yet it is reported, that in the Low Countries they will graft an apple cion upon the stock of a colewort, and it will bear a great flaggy apple, the kernel of which, if it be set, will be a colewort, and not an apple. It were good to try whether an apple cion will prosper, if it be grafted upon a sallow, or upon a poplar, or upon an alder, or upon an elm, or upon an horse-plum, which are the moistest of trees. I have heard that it hath been tried upon an elm, and succeeded.

454. It is manifest by experience, that flowers removed wax greater, because the nourishment is more easily come by in the loose earth. It may be, that oft regrafting of the same cion may likewise make fruit greater; as if you take a cion and graft it upon a stock the first year, and then cut it off and graft it upon another stock the second year, and so for a third or fourth year, and then let it rest, it will yield afterward, when it beareth, the greater fruit.

Of grafting there are many experiments worth the noting, but those we reserve to a proper place.

455. It maketh figs better, if a fig-tree, when it beginneth to put forth leaves, have his top cut off. The cause is plain, for that the sap hath the less to feed, and the less way to mount: but it may be the

fig will come somewhat later, as was formerly touched. The same may be tried likewise in other trees.

456. It is reported, that mulberries will be fairer, and the trees more fruitful, if you bore the trunk of the tree through in several places, and thrust into the places bored wedges of some hot trees, as turpentine, mastic-tree, guaiacum, juniper, &c. The cause may be, for that adventive heat doth cheer up the native juice of the tree.

457. It is reported, that trees will grow greater, and bear better fruit, if you put salt, or lees of wine, or blood to the root. The cause may be the increasing the lust or spirit of the root; these things being more forcible than ordinary composts.

458. It is reported by one of the ancients, that artichokes will be less prickly, and more tender, if the seeds have their tops dulled, or grated off upon a stone.

459. Herbs will be tenderer and fairer, if you take them out of beds, when they are newly come up, and remove them into pots with better earth. The remove from bed to bed was spoken of before; but that was in several years; this is upon the sudden; The cause is the same with other removes formerly mentioned.

460. Coleworts are reported by one of the ancients to prosper exceedingly, and to be better tasted, if they be sometimes watered with salt water, and much more with water mixed with nitre; the spirit of which is less adurent than salt.

461. It is reported, that cucumbers will prove more tender and dainty, if their seeds be steeped a little in milk; the cause may be, for that the seed being mollified with the milk, will be too weak to draw the grosser juice of the earth, but only the finer. The same experiment may be made in artichokes and other seeds, when you would take away either their flashiness or bitterness. They speak also, that the like effect followeth of steeping in water mixed with honey; but that seemeth to me not so probable, because honey hath too quick a spirit.

462. It is reported, that cucumbers will be less watery, and more melon-like, if in the pit where you set them, you fill it, half way up, with chaff or small sticks, and then pour earth upon them: for cucumbers, as it seemeth, do extremely affect moisture, and over-drink themselves, which the chaff or chips forbiddeth. Nay, it is farther reported, that if, when a cucumber is grown, you set a pot of water about five or six inches distance from it, it will, in twenty-four hours, shoot so much out as to touch the pot; which, if it be true, is an experiment of a higher nature than belongeth to this title: for it discovereth perception in plants, to move towards that which should help and comfort them, though it be at a distance. The ancient tradition of the vine is far more strange: it is, that if you set a stake or prop some distance from it, it will grow that way, which is far stranger, as is said, than the other; for that water may work by a sympathy of attraction,

but this of the stake seemeth to be a reasonable discourse.

463. It hath been touched before, that terebration of trees doth make them prosper better. But it is found also, that it maketh the fruit sweeter and better. The cause is, for that, notwithstanding the terebration, they may receive aliment sufficient, and yet no more than they can well turn and digest, and withal do sweat out the coarsest and unprofitablest juice; even as it is in living creatures, which by moderate feeding, and exercise, and sweat, attain the soundest habit of body.

464. As terebration doth meliorate fruit, so upon the like reason doth letting of plants blood, as pricking vines or other trees, after they be of some growth, and thereby letting forth gum or tears, though this be not to continue, as it is in terebration, but at some seasons. And it is reported, that by this artifice bitter almonds have been turned into sweet.

465. The ancients for the dulcorating of fruit do commend swine's dung above all other dung: which may be because of the moisture of that beast, whereby the excrement hath less acrimony, for we see swines and pig's flesh is the moisest of fleshes.

466. It is observed by some, that all herbs wax sweeter, both in smell and taste, if after they be grown up some reasonable time they be cut, and so you take the latter sprout. The cause may be, for that the longer the juice stayeth in the root and stalk, the better it concocteth. For one of the chief

causes why grains, seeds, and fruits, are more nourishing than leaves, is the length of time in which they grow to maturation. It were not amiss to keep back the sap of herbs, or the like, by some fit means, till the end of summer, whereby it may be, they will be more nourishing.

467. As grafting doth generally advance and meliorate fruits, above that which they would be if they were set of kernels or stones, in regard the nourishment is better concocted; so, no doubt, even in grafting, for the same cause, the choice of the stock doth much, always provided that it be somewhat inferior to the cion, for otherwise it dulleth it. They commend much the grafting of pears or apples upon a quince.

468. Besides the means of melioration of fruits before mentioned, it is set down as tried, that a mixture of bran and swines' dung, or chaff and swines dung, especially laid up together for a month to rot, is a very great nourisher and comforter to a fruit-tree.

469. It is delivered, that onions wax greater if they be taken out of the earth, and laid a drying twenty days, and then set again; and yet more, if the outermost pill be taken off all over.

470. It is delivered by some, that if one take the bough of a low fruit-tree newly budded, and draw it gently, without hurting it, into an eathern pot perforate at the bottom to let in the plant, and then cover the pot with earth, it will yield a very large fruit within the ground. Which expe-

riment is nothing but potting of plants without removing, and leaving the fruit in the earth. The like, they say, will be effected by an empty pot without earth in it, put over a fruit, being propped up with a stake, as it hangeth upon the tree; and the better, if some few pertusions be made in the pot. Wherein, besides the defending of the fruit from extremity of sun or weather, some give a reason, that the fruit loving and coveting the open air and sun, is invited by those pertusions to spread and approach as near the open air as it can; and so enlargeth in magnitude.

471. All trees in high and sandy grounds are to be set deep, and in watery grounds more shallow. And in all trees, when they be removed, especially fruit-trees, care ought to be taken, that the sides of the trees be coasted, north and south, &c. as they stood before. The same is said also of stone out of the quarry, to make it more durable, though that seemeth to have less reason; because the stone lieth not so near the sun, as the tree groweth.

472. Timber trees in a coppice wood do grow better than in an open field; both because they offer not to spread so much, but shoot up still in height; and chiefly because they are defended from too much sun and wind, which do check the growth of all fruit; and so, no doubt, fruit-trees, or vines, set upon a wall against the sun, between elbows or buttresses of stone, ripen more than upon a plain wall.

473. It is said, that if potado-roots be set in a

pot filled with earth, and then the pot with earth be set likewise within the ground some two or three inches, the roots will grow greater than ordinary. The cause may be, for that having earth enough within the pot to nourish them; and then being stopped by the bottom of the pot from putting strings downward, they must needs grow greater in breadth and thickness. And it may be, that all seeds or roots potted, and so set into the earth, will prosper the better.

474. The cutting off the leaves of radish, or other roots, in the beginning of winter, before they wither, and covering again the root something high with earth, will preserve the root all winter, and make it bigger in the spring following, as hath been partly touched before. So that there is a double use of this cutting off the leaves; for in plants where the root is the esculent, as radish and parsnips, it will make the root the greater, and so it will do to the heads of onions. And where the fruit is the esculent, by strengthening the root, it will make the fruit also the greater.

475. It is an experiment of great pleasure, to make the leaves of shady trees larger than ordinary. It hath been tried for certain that a cion of a weech-elm, grafted upon the stock of an ordinary elm, will put forth leaves almost as broad as the brim of one's hat. And it is very likely, that as in fruit-trees the graft maketh a greater fruit; so in trees that bear no fruit, it will make the greater leaves. It would be tried therefore in trees of that kind chiefly, as

birch, asp, willow, and especially the shining willow, which they call swallow-tail, because of the pleasure of the leaf.

476. The barrenness of trees by accident, besides the weakness of the soil, seed, or root; and the injury of the weather, cometh either of their overgrowing with moss, or their being hide-bound, or their planting too deep, or by issuing of the sap too much into the leaves. For all these there are remedies mentioned before.

Experiments in consort touching compound fruits and flowers.

We see that in living creatures, that have male and female, there is copulation of several kinds; and so compound creatures, as the mule, that is generated betwixt the horse and the ass, and some other compounds which we call monsters, though more rare; and it is held that that proverb, *Africa semper aliquid monstri parit*, cometh, for that the fountains of waters there being rare, divers sorts of beasts come from several parts to drink, and so being refreshed, fall to couple, and many times with several kinds. The compounding or mixture of kinds in plants is not found out; which, nevertheless, if it be possible, is more at command than that of living creatures, for that their lust requireth a voluntary motion; wherefore it were one of the most noble experiments touching plants to find it out: for so you may have great variety of new fruits and flowers yet unknown. Grafting doth it

not, that mendeth the fruit, or doubleth the flowers, &c. but it hath not the power to make a new kind. For the cion ever over-ruleth the stock.

477. It hath been set down by one of the ancients, that if you take two twigs of several fruit-trees, and flat them on the sides, and then bind them close together and set them in the ground, they will come up in one stock; but yet they will put forth their several fruits without any commixture in the fruit. Wherein note by the way, that unity of continuance is easier to procure than unity of species. It is reported also, that vines of red and white grapes being set in the ground, and the upper parts being flatted and bound close together, will put forth grapes of several colours upon the same branch; and grape-stones of several colours within the same grape: but the more after a year or two, the unity, as it seemeth, growing more perfect. And this will likewise help, if from the first uniting they be often watered, for all moisture helpeth to union. And it is prescribed also to bind the bud as soon as it cometh forth, as well as the stock, at the least for a time.

478. They report, that divers seeds put into a clout, and laid in earth well dunged, will put up plants contiguous; which, afterwards being bound in, their shoots will incorporate. The like is said of kernels put into a bottle with a narrow mouth filled with earth.

479. It is reported, that young trees of several kinds set contiguous without any binding, and very

often watered, in a fruitful ground, with the very luxury of the trees will incorporate and grow together. Which seemeth to me the likeliest means that hath been propounded; for that the binding doth hinder the natural swelling of the tree; which, while it is in motion, doth better unite.

Experiments in consort touching the sympathy and antipathy of plants.

There are many ancient and received traditions and observations touching the sympathy and antipathy of plants; for that some will thrive best growing near others, which they impute to sympathy, and some worse, which they impute to antipathy. But these are idle and ignorant conceits, and forsake the true indication of the causes, as the most part of experiments that concern sympathies and antipathies do. For as to plants, neither is there any such secret friendship or hatred as they imagine; and if we should be content to call it sympathy and antipathy, it is utterly mistaken, for their sympathy is an antipathy, and their antipathy is a sympathy, for it is thus: Wheresoever one plant draweth such a particular juice out of the earth, as it qualifieth the earth, so as that juice which remaineth is fit for the other plant; there the neighbourhood doth good, because the nourishments are contrary or several: but where two plants draw much the same juice, there the neighbourhood hurteth, for the one deceiveth the other.

480. First therefore, all plants that do draw

much nourishment from the earth, and so soak the earth and exhaust it, hurt all things that grow by them; as great trees, aspecially ashes, and such trees as spread their roots near the top of the ground. So the colewort is not an enemy, though that were anciently received, to the vine only; but it is an enemy to any other plant, because it draweth strongly the fattest juice of the earth. And if it be true, that the vine when it creepeth near the colewort will turn away, this may be, because there it findeth worse nourishment; for though the root be where it was, yet, I doubt, the plant will bend as it nourisheth.

481. Where plants are of several natures, and draw several juices out of the earth, there, as hath been said, the one set by the other helpeth: as it is set down by divers of the ancients, that rue doth prosper much, and becometh stronger, if it be set by a fig-tree, which, we conceive, is caused not by reason of friendship, but by extraction of a contrary juice; the one drawing juice fit to result sweet, the other bitter. So they have set down likewise, that a rose set by garlic is sweeter: which likewise may be, because the more fetid juice of the earth goeth into the garlic, and the more odorate into the rose.

482. This we see manifestly, that there be certain corn-flowers which come seldom or never in other places, unless they be set, but only amongst corn: as the blue bottle, a kind of yellow marygold, wild poppy, and fumitory. Neither can this be, by reason of the culture of the ground, by ploughing or furrowing; as some herbs and flowers will grow but

in ditches new cast; for if the ground lie fallow and unsown, they will not come: so as it should seem to be the corn that qualifieth the earth, and prepareth it for their growth.

483. This observation, if it holdeth, as it is very probable, is of great use for the meliorating of taste in fruits and esculent herbs, and of the scent of flowers. For I do not doubt, but if the fig-tree do make the rue more strong and bitter, as the ancients have noted, good store of rue planted about the fig-tree will make the fig more sweet. Now the tastes that do most offend in fruits, and herbs, and roots, are bitter, harsh, sour, and waterish, or flabby. It were good therefore to make the trials following.

484. Take wormwood, or rue, and set it near lettuce, or coleflory, or artichoke, and see whether the lettuce, or the coleflory, &c. become not the sweeter.

485. Take a service-tree, or a cornelian-tree, or an elder-tree, which we know have fruits of harsh and binding juice, and set them near a vine, or fig-tree, and see whether the grapes or figs will not be the sweeter.

486. Take cucumbers or pumpions, and set them here and there, amongst musk-melons, and see whether the melons will not be more winy, and better tasted. Set cucumbers, likewise, amongst radish, and see whether the radish will not be made the more biting.

487. Take sorrel, and set it amongst rasps, and see whether the rasps will not be the sweeter.

488. Take common briar, and set it amongst

violets or wall-flowers, and see whether it will not make the violets or wall-flowers sweeter, and less earthy in their smell. So set lettuce or cucumbers amongst rosemary or bays, and see whether the rosemary or bays will not be the more odorate or aromatical.

489. Contrariwise, you must take heed how you set herbs together, that draw much the like juice. And therefore I think rosemary will lose in sweetness, if it be set with lavender, or bays, or the like. But yet if you will correct the strength of an herb, you shall do well to set other like herbs by him to take him down; as if you should set tansey by angelica, it may be the angelica would be the weaker, and fitter for mixture in perfume. And if you should set rue by common wormwood, it may be the wormwood would turn to be liker Roman wormwood.

490. This axiom is of large extent; and therefore would be severed, and refined by trial. Neither must you expect to have a gross difference by this kind of culture, but only farther perfection.

491. Trial would be also made in herbs poisonous and purgative, whose ill quality, perhaps, may be discharged, or attempered, by setting stronger poisons or purgatives by them.

492. It is reported, that the shrub called our ladies seal, which is a kind of briony, and coleworts, set near together, one or both will die. The cause is, for that they be both great depredators of the earth, and one of them starveth the other. The like is said of a reed and a brake; both of which are suc-

culent, and therefore the one deceiveth the other. And the like of hemlock and rue; both which draw strong juices.

493. Some of the ancients, and likewise divers of the modern writers, that have laboured in natural magic, have noted a sympathy between the sun, moon, and some principal stars, and certain herbs and plants. And so they have denominated some herbs solar, and some lunar; and such like toys put into great words. It is manifest that there are some flowers that have respect to the sun in two kinds, the one by opening and shutting, and the other by bowing and inclining the head. For marygolds, tulips, pimpernel, and indeed most flowers, do open and spread their leaves abroad when the sun shineth serene and fair: and again, in some part, close them, or gather them inward, either towards night, or when the sky is overcast. Of this there needeth no such solemn reason to be assigned, as to say, that they rejoice at the presence of the sun, and mourn at the absence thereof. For it is nothing else but a little loading of the leaves, and swelling them at the bottom, with the moisture of the air, whereas the dry air doth extend them; and they make it a piece of the wonder, that garden clover will hide the stalk when the sun sheweth bright, which is nothing but a full expansion of the leaves. For the bowing and inclining the head, it is found in the great flower of the sun, in marygolds, wart-wort, mallow flowers, and others. The cause is somewhat more obscure than the former; but I take it to be no other, but

that the part against which the sun beateth waxeth more faint and flaccid in the stalk, and thereby less able to support the flower.

494. What a little moisture will do in vegetables, even though they be dead and severed from the earth, appeareth well in the experiment of jugglers. They take the beard of an oat, which if you mark it well, is wreathed at the bottom, and one smooth entire straw at the top. They take only the part that is wreathed, and cut off the other, leaving the beard half the breadth of a finger in length. Then they make a little cross of a quill, longways of that part of the quill which hath the pith; and cross-ways of that piece of the quill without pith; the whole cross being the breadth of a finger high. Then they prick the bottom where the pith is, and thereinto they put the oaten beard, leaving half of it sticking forth of the quill: then they take a little white box of wood, to deceive men, as if somewhat in the box did work the feat, in which, with a pin, they make a little hole, enough to take the beard, but not to let the cross sink down, but to stick. Then likewise, by way of imposture, they make a question; as, Who is the fairest woman in company? or, Who hath a glove or a card? and cause another to name divers persons; and upon every naming they stick the cross in the box, having first put it towards their mouth, as if they charmed it, and the cross stirreth not; but when they come to the person that they would take, as they hold the cross to their mouth, they touch the beard with the tip of their tongue

and wet it, and so stick the cross in the box; and then you shall see it turn finely and softly three or four turns, which is caused by the untwining of the beard by the moisture. You may see it more evidently, if you stick the cross between your fingers instead of the box; and therefore you may see, that this motion, which is effected by so little wet, is stronger than the closing or bending of the head of a marygold.

495. It is reported by some, that the herb called "rosa solis," whereof they make strong waters, will, at the noon-day, when the sun shineth hot and bright, have a great dew upon it. And therefore that the right name is "ros solis;" which they impute to a delight and sympathy that it hath with the sun. Men favour wonders. It were good first to be sure, that the dew that is found upon it, be not the dew of the morning preserved, when the dew of other herbs is breathed away; for it hath a smooth and thick leaf, that doth not discharge the dew so soon as other herbs that are more spungy and porous. And it may be purslane, or some other herb, doth the like, and is not marked. But if it be so, that it hath more dew at noon than in the morning, then sure it seemeth to be an exudation of the herb itself. As plums sweat when they are set into the oven: for you will not, I hope, think, that it is like Gideon's fleece of wool, that the dew should fall upon that and no where else.

496. It is certain, that the honey dews are found more upon oak leaves than upon ash, or beech, or

the like: but whether any cause be from the leaf itself to concoct the dew, or whether it be only that the leaf is close and smooth, and therefore drinketh not in the dew, but preserveth it, may be doubted. It would be well inquired, whether manna the drug doth fall but upon certain herbs or leaves only. Flowers that have deep sockets, do gather in the bottom a kind of honey, as honey-suckles, both the woodbine and the trefoil, lilies, and the like. And in them certainly the flower beareth part with the dew.

497. The experience is, that the froth which they call woodseare, being like a kind of spittle, is found but upon certain herbs, and those hot ones; as lavender, lavender-cotton, sage, hyssop, &c. Of the cause of this inquire further; for it seemeth a secret. There falleth also mildew upon corn, and smutteth it; but it may be, that the same falleth also upon other herbs, and is not observed.

498. It were good trial were made, whether the great consent between plants and water, which is a principal nourishment of them, will make an attraction at distance, and not at touch only. Therefore take a vessel, and in the middle of it make a false bottom of coarse canvas: fill it with earth above the canvas, and let not the earth be watered; then sow some good seeds in that earth; but under the canvas, some half a foot in the bottom of the vessel, lay a great spunge thoroughly wet in water; and let it lie so some ten days, and see whether the seeds will sprout, and the earth become more moist, and the

spunge more dry. The experiment formerly mentioned of the cucumber creeping to the pot of water, is far stranger than this.

Experiments in consort touching the making herbs and fruits medicinable.

499. The altering of the scent, colour, or taste of fruit, by infusing, mixing, or letting into the bark, or root of the tree, herb, or flower, any coloured, aromatical, or medicinal substance, are but fancies. The cause is, for that those things have passed their period, and nourish not. And all alteration of vegetables in those qualities must be by somewhat that is apt to go into the nourishment of the plant. But this is true, that where kine feed upon wild garlic, their milk tasteth plainly of the garlic: and the flesh of muttons is better tasted where the sheep feed upon wild thyme, and other wholesome herbs. Galen also speaketh of the curing of the "scirrus" of the liver, by milk of a cow that feedeth but upon certain herbs; and honey in Spain smelleth apparently of the rosemary, or orange, from whence the bee gathereth it: and there is an old tradition of a maiden that was fed with "napellus;" which is counted the strongest poison of all vegetables, which with use did not hurt the maid, but poisoned some that had carnal company with her. So it is observed by some, that there is a virtuous bezoar, and another without virtue, which appear to the shew alike: but the virtuous is taken from the beast that feedeth upon the mountains, where there are theriacal herbs,

and that without virtue, from those that feed in the vallies where no such herbs are. Thus far I am of opinion; that as steeped wines and beers are very medicinal; and likewise bread tempered with divers powders; so of meat also, as flesh, fish, milk, and eggs, that they may be made of great use for medicine and diet, if the beasts, fowl, or fish, be fed with a special kind of food fit for the disease. It were a dangerous thing also for secret empoisonments. But whether it may be applied unto plants and herbs, I doubt more, because the nourishment of them is a more common juice; which is hardly capable of any special quality, until the plant do assimilate it.

500. But lest our incredulity may prejudice any profitable operations in this kind, especially since many of the ancients have set them down, we think good briefly to propound the four means which they have devised of making plants medicinable. The first is by slitting of the root, and infusing into it the medicine; as hellebore, opium, scammony, treacle, &c. and then binding it up again. This seemeth to me the least probable; because the root draweth immediately from the earth; and so the nourishment is the more common and less qualified: and besides, it is a long time in going up ere it come to the fruit. The second way is to perforate the body of the tree, and there to infuse the medicine; which is somewhat better: for if any virtue be received from the medicine, it hath the less way, and the less time to go up. The third is, the steeping of the seed or kernel in some liquor wherein the medicine

is infused: which I have little opinion of, because the seed, I doubt, will not draw the parts of the matter which have the propriety: but it will be far the more likely, if you mingle the medicine with dung; for that the seed naturally drawing the moisture of the dung, may call in withal some of the propriety. The fourth is, the watering of the plant oft with an infusion of the medicine. This, in one respect, may have more force than the rest, because the medication is oft renewed; whereas the rest are applied but at one time; and therefore the virtue may the sooner vanish. But still I doubt, that the root is somewhat too stubborn to receive those fine impressions; and besides, as I said before, they have a great hill to go up. I judge therefore the likeliest way to be the perforation of the body of the tree in several places one above the other; and the filling of the holes with dung mingled with the medicine; and the watering of those lumps of dung with squirts of an infusion of the medicine in dunged water, once in three or four days.

NATURAL HISTORY.

CENTURY VI.

Experiments in consort touching curiosities about fruits and plants.

Our experiments we take care to be, as we have often said, either "experimenta fructifera," or "lucifera;" either of use, or of discovery: for we hate impostures, and despise curiosities. Yet because we must apply ourselves somewhat to others, we will set down some curiosities touching plants.

501. It is a curiosity to have several fruits upon one tree; and the more, when some of them come early, and some come late, so that you may have upon the same tree ripe fruits all summer. This is easily done by grafting of several cions upon several boughs of a stock, in a good ground plentifully fed. So you may have all kinds of cherries, and all kinds of plums, and peaches, and apricots, upon one tree; but I conceive the diversity of fruits must be such as will graft upon the same stock. And therefore I doubt, whether you can have apples, or pears, or oranges, upon the same stock upon which you graft plums.

502. It is a curiosity to have fruits of divers shapes and figures. This is easily performed, by molding them when the fruit is young, with molds

of earth or wood. So you may have cucumbers, &c. as long as a cane; or as round as a sphere; or formed like a cross. You may have also apples in the form of pears or lemons. You may have also fruit in more accurate figures, as we said of men, beasts, or birds, according as you make the molds. Wherein you must understand, that you make the mold big enough to contain the whole fruit when it is grown to the greatest: for else you will choke the spreading of the fruit; which otherwise would spread itself, and fill the concave, and so be turned into the shape desired; as it is in mold works of liquid things. Some doubt may be conceived, that the keeping of the sun from the fruit may hurt it: but there is ordinary experience of fruit that groweth covered. Query, also, whether some small holes may not be made in the wood to let in the sun. And note, that it were best to make the molds partible, glued, or cemented together, that you may open them when you take out the fruit.

503. It is a curiosity to have inscriptions, or engravings, in fruit or trees. This is easily performed, by writing with a needle, or bodkin, or knife, or the like, when the fruit or trees are young; for as they grow, so the letters will grow more large and graphical,

—Tenerisque meos incidere amores
Arboribus; crescent illæ, crescetis amores.

504. You may have trees apparelled with flowers or herbs, by boring holes in the bodies of them, and

putting into them earth holpen with muck, and setting seeds, or slips, of violets, strawberries, wild thyme, camomile, and such like, in the earth. Wherein they do but grow in the tree as they do in pots; though, perhaps, with some feeding from the trees. It would be tried also with shoots of vines, and roots of red roses; for it may be they being of a more ligneous nature, will incorporate with the tree itself.

505. It is an ordinary curiosity to form trees and shrubs, as rosemary, juniper, and the like, into sundry shapes; which is done by molding them within, and cutting them without. But they are but lame things, being too small to keep figure; great castles made of trees upon frames of timber, with turrets and arches, were antiently matters of magnificence.

506. Amongst curiosities I shall place coloration, though it be somewhat better; for beauty in flowers is their pre-eminence. It is observed by some, that gilly-flowers, sweet-williams, violets, that are coloured, if they be neglected, and neither watered, nor new molded, nor transplanted, will turn white. And it is probable that the white with much culture may turn coloured. For this is certain, that the white colour cometh of scarcity of nourishment; except in flowers that are only white, and admit no other colours.

507. It is good therefore to see what natures do accompany what colours; for by that you shall have light how to induce colours, by producing those natures. Whites are more inodorate, for the most

part, than flowers of the same kind coloured; as is found in single white violets, white roses, white gilly-flowers, white stock-gilly-flowers, &c. We find also that blossoms of trees, that are white, are commonly inodorate, as cherries, pears, plums; whereas those of apples, crabs, almonds, and peaches, are blushy, and smell sweet. The cause is, for that the substance that maketh the flower is of the thinnest and finest of the plant, which also maketh flowers to be of so dainty colours. And if it be too sparing and thin, it attaineth no strength of odour, except it be in such plants as are very succulent; whereby they need rather to be scanted in their nourishment than replenished, to have them sweet. As we see in white satyrion, which is of a dainty smell; and in bean-flowers, &c. And again, if the plant be of nature to put forth white flowers only, and those not thin or dry, they are commonly of rank and fulsome smell; as may-flowers, and white lilies.

508. Contrariwise, in berries the white is commonly more delicate and sweet in taste than the coloured, as we see in white grapes, in white rasps, in white strawberries, in white currants, &c. The cause is, for that the coloured are more juiced, and coarser juiced, and therefore not so well and equally concocted; but the white are better proportioned to the digestion of the plant.

509. But in fruits the white commonly is meaner: as in pear-plums, damascenes, &c. and the choicest plums are black; the mulberry, which though they call it a berry, is a fruit, is better the

black than the white. The harvest white plum is a base plum; and the verdoccio, and white date-plum, are no very good plums. The cause is, for that they are all over-watery; whereas an higher concoction is required for sweetness, or pleasure of taste; and therefore all your dainty plums are a little dry, and come from the stone; as the muscle-plum, the damascene-plum, the peach, the apricot, &c. yet some fruits, which grow not to be black, are of the nature of berries, sweetest such as are paler; as the cœur-cherry, which inclineth more to white, is sweeter than the red; but the egriot is more sour.

510. Take gilly-flower seed, of one kind of gilly-flower, as of the clove-gilly-flower, which is the most common, and sow it, and there will come up gilly-flowers some of one colour, and some of another, casually, as the seed meeteth with nourishment in the earth; so that the gardeners find, that they may have two or three roots amongst an hundred that are rare and of great price; as purple, carnation of several stripes: the cause is, no doubt, that in earth, though it be contiguous, and in one bed, there are very several juices; and as the seed doth casually meet with them, so it cometh forth. And it is noted especially, that those which do come up purple, do always come up single: the juice, as it seemeth, not being able to suffice a succulent colour, and a double leaf. This experiment of several colours coming up from one seed, would be tried also in larks-foot, monks-hood, poppy, and holyoak.

511. Few fruits are coloured red within: the

queen-apple is; and another apple, called the rose-apple: mulberries, likewise, and grapes, though most toward the skin. There is a peach also that hath a circle of red towards the stone: and the egriot cherry is somewhat red within; but no pear, nor warden, nor plum, nor apricot, although they have many times red sides, are coloured red within. The cause may be inquired.

512. The general colour of plants is green, which is a colour that no flower is of. There is a greenish primrose, but it is pale, and scarce a green. The leaves of some trees turn a little murry or reddish and they be commonly young leaves that do so; as it is in oaks, and vines, and hazle. Leaves rot into a yellow, and some hollies have part of their leaves yellow, that are, to all seeming, as fresh and shining as the green. I suppose also, that yellow is a less succulent colour than green, and a degree nearer white. For it hath been noted, that those yellow leaves of holly stand ever towards the north or north-east. Some roots are yellow, as carrots; and some plants blood-red, stalk and leaf, and all, as amaranthus. Some herbs incline to purple and red; as a kind of sage doth, and a kind of mint, and rosa solis, &c. And some have white leaves, as another kind of sage, and another kind of mint; but azure and a fair purple are never found in leaves. This sheweth, that flowers are made of a refined juice of the earth, and so are fruits; but leaves of a more coarse and common.

513. It is a curiosity also to make flowers double,

which is effected by often removing them into new earth: as, on the contrary part, double flowers, by neglecting and not removing, prove single. And the way to do it speedily, is to sow or set seeds or slips of flowers; and as soon as they come up, to remove them into new ground that is good. Inquire also, whether inoculating of flowers, as stock-gilly-flowers, roses, musk-roses, &c. doth not make them double. There is a cherry-tree that hath double blossoms; but that tree beareth no fruit: and it may be, that the same means which, applied to the tree, doth extremely accelerate the sap to rise and break forth, would make the tree spend itself in flowers, and those to become double: which were a great pleasure to see, especially in apple-trees, peach-trees, and almond-trees, that have blossoms blush-coloured.

514. The making of fruits without core or stone, is likewise a curiosity, and somewhat better; because whatsoever maketh them so, is like to make them more tender and delicate. If a cion or shoot, fit to be set in the ground, have the pith finely taken forth, and not altogether, but some of it left, the better to save the life, it will bear a fruit with little or no core or stone. And the like is said to be of dividing a quick tree down to the ground, and taking out the pith, and then binding it up again.

515. It is reported also, that a citron grafted upon a quince will have small or no seeds; and it is

very probable that any sour fruit grafted upon a stock that beareth a sweeter fruit, may both make the fruit sweeter, and more void of the harsh matter of kernels or seeds.

516. It is reported, that not only the taking out of the pith, but the stopping of the juice of the pith from rising in the midst, and turning it to rise on the outside, will make the fruit without core or stone; as if you should bore a tree clean through, and put a wedge in. It is true, there is some affinity between the pith and the kernel, because they are both of a harsh substance, and both placed in the midst.

517. It is reported, that trees watered perpetually with warm water, will make a fruit with little or no core or stone. And the rule is general, that whatsoever will make a wild tree a garden tree, will make a garden tree to have less core or stone.

Experiments in consort touching the degenerating of plants, and of the transmutation of them into one another.

518. The rule is certain, that plants for want of culture degenerate to be baser in the same kind; and sometimes so far as to change into another kind, 1. The standing long, and not being removed, maketh them degenerate. 2. Drought, unless the earth of itself be moist, doth the like. 3. So doth removing into worse earth, or forbearing to com-

post the earth; as we see that water mint turneth into field mint, and the colewort into rape, by neglect, &c.

519. Whatsoever fruit useth to be set upon a root or a slip, if it be sown, will degenerate. Grapes sown, figs, almonds, pomegranate kernels sown, make the fruits degenerate and become wild. And again, most of those fruits that use to be grafted, if they be set of kernels, or stones, degenerate. It is true that peaches, as hath been touched before, do better upon stones set than upon grafting; and the rule of exception should seem to be this: that whatsoever plant requireth much moisture, prospereth better upon the stone or kernel, than upon the graft. For the stock, though it giveth a finer nourishment, yet it giveth a scanter than the earth at large.

520. Seeds, if they be very old, and yet have strength enough to bring forth a plant, make the plant degenerate. And therefore skilful gardeners make trial of the seeds before they buy them, whether they be good or no, by putting them into water gently boiled; and if they be good, they will sprout within half an hour.

521. It is strange which is reported, that basil too much exposed to the sun doth turn into wild thyme; although those two herbs seem to have small affinity; but basil is almost the only hot herb that hath fat and succulent leaves, which oiliness, if it be drawn forth by the sun, it is like it will make a very great change.

522. There is an old tradition, that boughs of oak put into the earth will put forth wild vines: which, if it be true, no doubt it is not the oak that turneth into a vine, but the oak-bough putrifying, qualifieth the earth to put forth a vine of itself.

523. It is not impossible, and I have heard it verified, that upon cutting down of an old timber tree, the stub hath put out sometimes a tree of another kind; as that beech hath put forth birch; which, if it be true, the cause may be, for that the old stub is too scant of juice to put forth the former tree; and therefore putteth forth a tree of a smaller kind, that needeth less nourishment.

524. There is an opinion in the country, that if the same ground be oft sown with the grain that grew upon it, it will in the end grow to be of a baser kind.

525. It is certain, that in very steril years corn sown will grow to another kind.

> "Grandia sæpe quibus mandavimus hordea sulcis,
> "Infelix lolium, et steriles dominantur avenæ."

And generally it is a rule, that plants that are brought forth by culture, as corn, will sooner change into other species than those that come of themselves; for that culture giveth but an adventitious nature, which is more easily put off.

This work of the transmutation of plants one into another, is "inter magnalia naturæ:" for the transmutation of species is, in the vulgar philosophy, pronounced impossible, and certainly it is a thing of difficulty, and requireth deep search into nature;

but seeing there appear some manifest instances of it, the opinion of impossibility is to be rejected, and the means thereof to be found out. We see, that in living creatures, that come of putrefaction, there is much transmutation of one into another, as caterpillars turn into flies, &c. And it should seem probable, that whatsoever creature, having life, is generated without seed, that creature will change out of one species into another. For it is the seed, and the nature of it, which locketh and boundeth in the creature, that it doth not expatiate. So as we may well conclude, that seeing the earth of itself doth put forth plants without seed, therefore plants may well have a transmigration of species. Wherefore, wanting instances which do occur, we shall give directions of the most likely trials; and generally we would not have those that read this work of "Sylva sylvarum" account it strange, or think that it is an over-haste, that we have set down particulars untried; for contrariwise, in our own estimation, we account such particulars more worthy than those that are already tried and known; for these latter must be taken as you find them; but the other do level point-blank at the inventing of causes and axioms.

526. First, therefore, you must make account, that if you will have one plant change into another, you must have the nourishment over-rule the seed; and therefore you are to practise it by nourishment as contrary as may be to the nature of the herb, so nevertheless as the herb may grow, and likewise

with seeds that are of the weakest sort, and have least vigour. You shall do well, therefore, to take marsh-herbs, and plant them on tops of hills and champaigns; and such plants as require much moisture, upon sandy and very dry grounds. As for example, marsh-mallows and sedge, upon hills; cucumber, and lettuce seeds, and coleworts, upon a sandy plot; so contrariwise, plant bushes, heath, ling, and brakes, upon a wet or marsh ground. This I conceive also, that all esculent and garden herbs, set upon the tops of hills, will prove more medicinal, though less esculent than they were before. And it may be likewise, some wild herbs you may make sallad herbs. This is the first rule for transmutation of plants.

527. The second rule shall be, to bury some few seeds of the herb you would change, amongst other seeds; and then you shall see whether the juice of those other seeds do not so qualify the earth, as it will alter the seed whereupon you work. As for example, put parsley seed amongst onion seed, or lettuce seed amongst parsley seed, or basil seed amongst thyme seed; and see the change of taste or otherwise. But you shall do well to put the seed you would change into a little linen cloth, that it mingle not with the foreign seed.

528. The third rule shall be, the making of some medley or mixture of earth with some other plants bruised or shaven either in leaf or root; as for example, make earth with a mixture of colewort leaves stamped, and set in it artichokes or parsnips; so

take earth made with marjoram, or origanum, or wild thyme, bruised or stamped, and set in it fennel seed, &c. In which operation the process of nature still will be, as I conceive, not that the herb you work upon should draw the juice of the foreign herb, for that opinion we have formerly rejected, but there will be a new confection of mold, which perhaps will alter the seed, and yet not to the kind of the former herb.

529. The fourth rule shall be, to mark what herbs some earths do put forth of themselves, and to take that earth and to pot it, or to vessel it: and in that to set the seed you would change: as for example, take from under walls or the like, where nettles put forth in abundance, the earth, which you shall there find, without any string or root of the nettles; and pot that earth, and set in it stock-gilly-flowers, or wall-flowers, &c. or sow in the seeds of them, and see what the event will be; or take earth that you have prepared to put forth mushrooms of itself, whereof you shall find some instances following, and sow it in purslane seed, or lettuce seed; for in these experiments, it is likely enough that the earth being accustomed to send forth one kind of nourishment, will alter the new seed.

530. The fifth rule shall be, to make the herb grow contrary to its nature; as to make ground-herbs rise in height: as for example, carry camomile, or wild thyme, or the green strawberry upon sticks, as you do hops upon poles, and see what the event will be.

531. The sixth rule shall be, to make plants grow out of the sun or open air; for that is a great mutation in nature, and may induce a change in the seed; as barrel up earth and sow some seed in it, and put it in the bottom of a pond, or put it in some great hollow tree: try also the sowing of seeds in the bottoms of caves; and pots with seeds sown, hanged up in wells some distance from the water, and see what the event will be.

Experiments in consort touching the procevity, and lowness, and artificial dwarfing of trees.

532. It is certain, that timber trees in coppice woods grow more upright, and more free from under-boughs, than those that stand in the fields: the cause whereof is, for that plants have a natural motion to get to the sun; and besides, they are not glutted with too much nourishment; for that the coppice shareth with them, and repletion ever hindereth stature: lastly, they are kept warm, and that ever in plants helpeth mounting.

533. Trees that are of themselves full of heat, which heat appeareth by their inflammable gums, as firs and pines, mount of themselves in height without side-boughs, till they come towards the top. The cause is partly heat, and partly tenuity of juice, both which send the sap upwards. As for juniper, it is but a shrub, and groweth not big enough in body to maintain a tall tree.

534. It is reported, that a good strong canvas, spread over a tree grafted low, soon after it putteth

forth, will dwarf it, and make it spread. The cause is plain; for that all things that grow, will grow as they find room.

535. Trees are generally set of roots or kernels; but if you set them of slips, as of some trees you may, by name the mulberry, some of the slips will take; and those that take, as is reported, will be dwarf trees. The cause is, for that a slip draweth nourishment more weakly than either a root or kernel.

536. All plants that put forth their sap hastily, have their bodies not proportionable to their length, and therefore they are winders and creepers; as ivy, briony, hops, woodbine; whereas dwarfing requireth a slow putting forth, and less vigour of mounting.

Experiments in consort touching the rudiments of plants, and of the excrescences of plants, or super-plants.

The Scripture saith, that Solomon wrote a Natural History, "from the cedar of Libanus, to the "moss growing upon the wall;" for so the best translations have it. And it is true that moss is but the rudiment of a plant; and, as it were, the mold of earth or bark.

537. Moss groweth chiefly upon ridges of houses tiled or thatched, and upon the crests of walls; and that moss is of a lightsome and pleasant green. The growing upon slopes is caused, for that moss, as on the one side it cometh of moisture and water, so on the other side the water must but slide, and not stand or pool. And the growing upon tiles, or

walls, &c. is caused, for that those dried earths, having not moisture sufficient to put forth a plant, do practise germination by putting forth moss; though when, by age, or otherwise they grow to relent and resolve, they sometimes put forth plants, as wall-flowers. And almost all moss hath here and there little stalks, besides the low thrum.

538. Moss groweth upon alleys, especially such as lie cold and upon the north; as in divers terrasses: and again, if they be much trodden; or if they were at the first gravelled; for wheresoever plants are kept down, the earth putteth forth moss.

539. Old ground, that hath been long unbroken up, gathereth moss; and therefore husbandmen use to cure their pasture grounds when they grow to moss, by tilling them for a year or two: which also dependeth upon the same cause; for that the more sparing and starving juice of the earth, insufficient for plants, doth breed moss.

540. Old trees are more mossy far than young; for that the sap is not so frank as to rise all to the boughs, but tireth by the way, and putteth out moss.

541. Fountains have moss growing upon the ground about them;

"Muscosi fontes:"

The cause is, for that the fountains drain the water from the ground adjacent, and leave but sufficient moisture to breed moss: and besides, the coldness of the water conduceth to the same.

542. The moss of trees is a kind of hair; for it is the juice of the tree that is excerned, and doth not assimilate. And upon great trees the moss gathereth a figure like a leaf.

543. The moister sort of trees yield little moss; as we see in asps, poplars, willows, beeches, &c. which is partly caused for the reason that hath been given, of the frank putting up of the sap into the boughs; and partly for that the barks of those trees are more close and smooth than those of oaks and ashes; whereby the moss can the hardlier issue out.

544. In clay-grounds all fruit-trees grow full of moss, both upon body and boughs, which is caused partly by the coldness of the ground, whereby the plants nourish less, and partly by the roughness of the earth, whereby the sap is shut in, and cannot get up to spread so frankly as it should do.

545. We have said heretofore, that if trees be hide-bound, they wax less fruitful, and gather moss; and that they are holpen by hacking, &c. And, therefore, by the reason of contraries, if trees be bound in with cords, or some outward bands, they will put forth more moss: which, I think, happeneth to trees that stand bleak, and upon the cold winds. It would also be tried, whether, if you cover a tree somewhat thick upon the top after his polling, it will not gather more moss. I think also the watering of trees with cold fountain-water, will make them grow full of moss.

546. There is a moss the perfumers have, which

cometh out of apple trees, that hath an excellent scent. Query, particularly for the manner of the growth, and the nature of it. And for this experiment's sake, being a thing of price, I have set down the last experiments how to multiply and call on mosses.

Next unto moss, I will speak of mushrooms; which are likewise an imperfect plant. The mushrooms have two strange properties; the one, that they yield so delicious a meat; the other, that they come up so hastily, as in a night; and yet they are unsown. And therefore such as are upstarts in state, they call in reproach mushrooms. It must needs be, therefore, that they be made of much moisture; and that moisture fat, gross, and yet somewhat concocted. And, indeed, we find that mushrooms cause the accident which we call "incubus," or the mare in the stomach. And therefore the surfeit of them may suffocate and empoison. And this sheweth that they are windy; and that windiness is gross and swelling, not sharp or griping. And upon the same reason mushrooms are a venerous meat.

547. It is reported, that the bark of white or red poplar, which are of the moistest of trees, cut small, and cast into furrows well dunged, will cause the ground to put forth mushrooms at all seasons of the year fit to be eaten. Some add to the mixture leaven of bread dissolved in water.

548. It is reported, that if a hilly field, where the stubble is standing, be set on fire in the showery season, it will put forth great store of mushrooms.

549. It is reported, that hartshorn, shaven, or in small pieces, mixed with dung and watered, putteth up mushrooms. And we know that hartshorn is of a fat and clammy substance: and it may be ox-horn would do the like.

550. It hath been reported, though it be scarce credible, that ivy hath grown out of a stag's horn; which they suppose did rather come from a confrication of the horn upon the ivy, than from the horn itself. There is not known any substance but earth, and the procedures of earth, as tile, stone, &c. that yieldeth any moss or herby substance. There may be trial made of some seeds, as that of fennel-seed, mustard-seed, and rape-seed, put into some little holes made in the horns of stags, or oxen, to see if they will grow.

551. There is also another imperfect plant, that in shew is like a great mushroom: and it is sometimes as broad as one's hat; which they call a toad's stool; but it is not esculent; and it groweth, commonly, by a dead stub of a tree, and likewise about the roots of rotten trees: and therefore seemeth to take his juice from wood putrified. Which sheweth, by the way, that wood putrified yieldeth a frank moisture.

552. There is a cake that groweth upon the side of a dead tree, that hath gotten no name, but it is large, and of a chesnut colour, and hard and pithy; whereby it should seem, that even dead trees forget not their putting forth; no more than the car-

cases of men's bodies, that put forth hair and nails for a time.

553. There is a cod, or bag, that groweth commonly in the fields; that at the first is hard like a tennis-ball, and white; and after groweth of a mushroom colour, and full of light dust upon the breaking, and is thought to be dangerous for the eyes if the powder get into them, and to be good for kibes. Belike it hath a corrosive and fretting nature.

554. There is an herb called Jew's ear, that groweth upon the roots and lower parts of the bodies of trees; especially of elders, and sometimes ashes. It hath a strange property; for in warm water it swelleth, and openeth extremely. It is not green, but of a dusky brown colour. And it is used for squinancies and inflammations in the throat; whereby it seemeth to have a mollifying and lenifying virtue.

555. There is a kind of spungy excrescence, which groweth chiefly upon the roots of the laser-tree; and sometimes upon cedar and other trees. It is very white, and light, and friable; which we call agaric. It is famous in physic for the purging of tough phlegm. And it is also an excellent opener for the liver; but offensive to the stomach: and in taste, it is at the first sweet, and after bitter.

556. We find no super-plant that is a formed plant, but misseltoe. They have an idle tradition, that there is a bird called a missel bird, that feedeth

a seed, which many times she cannot digest, and so expelleth it whole with her excrement: which falling upon a bough of a tree that hath some rift, putteth forth the misseltoe. But this is a fable, for it is not probable that birds should feed upon that they cannot digest. But allow that, yet it cannot be for other reasons: for first, it is found but upon certain trees; and those trees bear no such fruit, as may allure that bird to sit and feed upon them. It may be, that bird feedeth upon the misseltoe-berries, and so is often found there; which may have given occasion to the tale. But that which maketh an end of the question is, that misseltoe hath been found to put forth under the boughs, and not only above the boughs; so it cannot be any thing that falleth upon the bough. Misseltoe groweth chiefly upon crab-trees, apple-trees, sometimes upon hazles, and rarely upon oaks; the misseltoe whereof is counted very medicinal. It is ever green winter and summer, and beareth a white glistering berry: and it is a plant utterly differing from the plant upon which it groweth. Two things therefore may be certainly set down: first, that superfœtation must be by abundance of sap in the bough that putteth it forth: secondly, that that sap must be such as the tree doth excern, and cannot assimilate; for else it would go into a bough, and besides, it seemeth to be more fat and unctuous than the ordinary sap of the tree; both by the berry, which is clammy; and by that it continueth green winter and summer, which the tree doth not.

557. This experiment of misseltoe may give light to other practices. Therefore trial would be made by ripping of the bough of a crab-tree in the bark, and watering of the wound every day with warm water dunged, to see if it would bring forth misseltoe, or any such like thing. But it were yet more likely to try it with some other watering or anointing, that were not so natural to the tree as water is; as oil, or barm of drink, &c. so they be such things as kill not the bough.

558. It were good to try, what plants would put forth, if they be forbidden to put forth their natural boughs; poll therefore a tree, and cover it some thickness with clay on the top, and see what it will put forth. I suppose it will put forth roots; for so will a cion, being turned down into clay: therefore, in this experiment also, the tree would be closed with somewhat that is not so natural to the plant as clay is. Try it with leather, or cloth, or painting, so it be not hurtful to the tree. And it is certain, that a brake hath been known to grow out of a pollard.

559. A man may count the prickles of trees to be a kind of excrescence; for they will never be boughs, nor bear leaves. The plants that have prickles are thorns, black and white; brier, rose, lemon-trees, crab-trees, gooseberry, berberry; these have it in the bough: the plants that have prickles in the leaf are, holly, juniper, whin-bush, thistle; nettles also have a small venomous prickle, so hath borage, but harmless. The cause must be hasty

putting forth, want of moisture, and the closeness of the bark, for the haste of the spirit to put forth, and the want of nourishment to put forth a bough, and the closeness of the bark, cause prickles in boughs, and therefore they are ever like a pyramis, for that the moisture spendeth after a little putting forth. And for prickles in leaves, they come also of putting forth more juice into the leaf than can spread in the leaf smooth, and therefore the leaves otherwise are rough, as borage and nettles are. As for the leaves of holly, they are smooth, but never plain, but as it were with folds, for the same cause.

560. There be also plants, that though they have no prickles, yet they have a kind of downy or velvet rind upon their leaves; as rose-campion, stock-gilly-flowers, colt's-foot; which down or nap cometh of a subtil spirit, in a soft or fat substance. For it is certain, that both stock-gilly-flowers and rose-campions, stamped, have been applied with success to the wrists of those that have had tertian or quartan agues; and the vapour of colt's-foot hath a sanative virtue towards the lungs, and the leaf also is healing in surgery.

561. Another kind of excrescence is an exudation of plants joined with putrefaction; as we see in oak-apples, which are found chiefly upon the leaves of oaks, and the like upon willows: and country people have a kind of prediction, that if the oak-apple broken be full of worms, it is a sign of a pestilent year, which is a likely thing, because they grow of corruption.

562. There is also upon sweet, or other brier, a fine tuft or brush of moss of divers colours; which if you cut you shall ever find full of little white worms.

Experiments in consort touching the producing of perfect plants without seed.

563. It is certain, that earth taken out of the foundations of vaults and houses, and bottoms of wells, and then put into pots, will put forth sundry kinds of herbs: but some time is required for the germination: for if it be taken but from a fathom deep, it will put forth the first year; if much deeper, not till after a year or two.

564. The nature of the plants growing out of earth so taken up, doth follow the nature of the mold itself; as if the mold be soft and fine, it putteth forth soft herbs, as grass, plantain, and the like; if the earth be harder and coarser, it putteth forth herbs more rough, as thistles, firs, &c.

565. It is common experience, that where alleys are close gravelled, the earth putteth forth the first year knot grass, and after spire grass. The cause is, for that the hard gravel or pebble at the first laying will not suffer the grass to come forth upright, but turneth it to find his way where it can; but after that the earth is somewhat loosened at the top, the ordinary grass cometh up.

566. It is reported, that earth being taken out of shady and watery woods some depth, and potted, will put forth herbs of a fat and juicy sub-

stance; as penny-wort, purslane, houseleek, penny-royal, &c.

567. The water also doth send forth plants, that have no roots fixed in the bottom, but they are less perfect plants, being almost but leaves, and those small ones; such is that we call duck-weed, which hath a leaf no bigger than a thyme leaf, but of a fresher green, and putteth forth a little string into the water far from the bottom. As for the water lily, it hath a root in the ground; and so have a number of other herbs that grow in ponds.

568. It is reported by some of the ancients, and some modern testimony likewise, that there be some plants that grow upon the top of the sea, being supposed to grow of some concretion of slime from the water, where the sun beateth hot, and where the sea stirreth little. As for alga marina, sea weed, and eryngium, sea thistle, both have roots; but the sea weed under the water, the sea thistle but upon the shore.

569. The ancients have noted, that there are some herbs that grow out of snow laid up close together and putrified, and that they are all bitter, and they name one specially, "flomus," which we call moth-mullein. It is certain, that worms are found in snow commonly, like earth-worms; and therefore it is not unlike, that it may likewise put forth plants.

570. The ancients have affirmed, that there are some herbs that grow out of stone, which may be, for that it is certain that toads have been found in

the middle of a free-stone. We see also that flints, lying above ground, gather moss; and wall-flowers, and some other flowers, grow upon walls; but whether upon the main brick or stone, or whether out of the lime or chinks, is not well observed: for elders and ashes have been seen to grow out of steeples; but they manifestly grow out of clefts; insomuch as when they grow big, they will disjoin the stone. And besides, it is doubtful whether the mortar itself putteth it forth, or whether some seeds be not let fall by birds. There be likewise rock-herbs, but I suppose those are where there is some mold or earth. It hath likewise been found, that great trees growing upon quarries have put down their root into the stone.

571. In some mines in Germany, as is reported, there grow in the bottom vegetables, and the workfolks use to say they have magical virtue, and will not suffer men to gather them.

572. The sea sands seldom bear plants. Whereof the cause is yielded by some of the ancients, for that the sun exhaleth the moisture before it can incorporate with the earth, and yield a nourishment for the plant. And it is affirmed also that sand hath always its root in clay; and that there be no veins of sand any great depth within the earth.

573. It is certain, that some plants put forth for a time of their own store, without any nourishment from earth, water, stone, &c. of which vide the experiment 29.

Experiments in consort touching foreign plants.

574. It is reported, that earth that was brought out of the Indies and other remote countries for ballast of ships, cast upon some grounds in Italy, did put forth foreign herbs, to us in Europe not known; and, that which is more, that of their roots, barks, and seeds, contused together, and mingled with other earth, and well watered with warm water, there came forth herbs much like the other.

575. Plants brought out of hot countries will endeavour to put forth at the same time that they usually do in their own climate; and therefore to preserve them, there is no more required, than to keep them from the injury of putting back by cold. It is reported also, that grain out of the hotter countries translated into the colder, will be more forward than the ordinary grain of the cold country. It is likely that this will prove better in grains than in trees, for that grains are but annual, and so the virtue of the seed is not worn out; whereas in a tree it is embased by the ground to which it is removed.

576. Many plants which grow in the hotter countries, being set in the colder, will nevertheless, even in those cold countries, being sown of seeds late in the spring, come up and abide most part of the summer; as we find it in orange and lemon seeds, &c. the seeds whereof sown in the end of April will bring forth excellent sallads, mingled with other herbs. And I doubt not, but the seeds of

clove-trees, and pepper seeds, &c. if they could come hither green enough to be sown, would do the like.

Experiments in consort touching the seasons in which plants come forth.

577. There be some flowers, blossoms, grains, and fruits, which come more early, and others which come more late in the year. The flowers that come early with us are primroses, violets, anemonies, water-daffodillies, crocus vernus, and some early tulips. And they are all cold plants; which therefore, as it should seem, have a quicker perception of the heat of the sun increasing than the hot herbs have; as a cold hand will sooner find a little warmth than an hot. And those that come next after are wall-flowers, cowslips, hyacinths, rosemary flowers, &c. and after them pinks, roses, flower-deluces, &c. and the latest are gilly-flowers, holyoaks, larksfoot, &c. The earliest blossoms are the blossoms of peaches, almonds, cornelians, mezerions, &c. and they are of such trees as have much moisture, either watery or oily. And therefore crocus vernus also, being an herb that hath an oily juice, putteth forth early; for those also find the sun sooner than the drier trees. The grains are, first rye and wheat, then oats and barley, then peas and beans. For though green peas and beans be eaten sooner, yet the dry ones that are used for horse meat, are ripe last; and it seemeth that the fatter grain cometh first. The earliest fruits are strawberries, cherries, gooseberries, currants; and after them early

apples, early pears, apricots, rasps; and after them, damascenes, and most kind of plums, peaches, &c.; and the latest are apples, wardens, grapes, nuts, quinces, almonds, sloes, brier-berries, hips, medlars, services, cornelians, &c.

578. It is to be noted, that, commonly, trees that ripen latest blossom soonest; as peaches, cornelians, sloes, almonds, &c.; and it seemeth to be a work of providence that they blossom so soon; for otherwise they could not have the sun long enough to ripen.

579. There be fruits, but rarely, that come twice a year; as some pears, strawberries, &c. And it seemeth they are such as abound with nourishment; whereby after one period, before the sun waxeth too weak, they can endure another. The violet also, amongst flowers, cometh twice a year, especially the double white; and that also is a plant full of moisture. Roses come twice, but it is not without cutting, as hath been formerly said.

580. In Muscovy, though the corn come not up till late spring, yet their harvest is as early as ours. The cause is, for that the strength of the ground is kept in with the snow; and we see with us, that if it be a long winter, it is commonly a more plentiful year: and after those kind of winters likewise, the flowers and corn, which are earlier and later, do come commonly at once, and at the same time, which troubleth the husbandman many times; for you shall have red roses and damask roses come together; and likewise the harvest of wheat and

barley. But this happeneth ever, for that the earlier stayeth for the later, and not that the later cometh sooner.

581. There be divers fruit trees in the hot countries, which have blossoms, and young fruit, and ripe fruit, almost all the year, succeeding one another. And it is said the orange hath the like with us for a great part of summer, and so also hath the fig. And no doubt the natural motion of plants is to have so; but that either they want juice to spend, or they meet with the cold of the winter; and therefore this circle of ripening cannot be but in succulent plants, and hot countries.

582. Some herbs are but annual, and die, root and all, once a year; as borage, lettuce, cucumbers, musk-melons, basil, tobacco, mustard-seed, and all kinds of corn: some continue many years; as hyssop, germander, lavender, fennel, &c. The cause of the dying is double; the first is, the tenderness and weakness of the seed, which maketh the period in a small time; as it is in borage, lettuce, cucumbers, corn, &c. and therefore none of these are hot. The other cause is, for that some herbs can worse endure cold; as basil, tobacco, mustard-seed. And these have all much heat.

Experiments in consort touching the lasting of herbs and trees.

583. The lasting of plants is most in those that are largest of body; as oaks, elm, chestnut, the loat-tree, &c. and this holdeth in trees; but in herbs it is

often contrary: for borage, colewort, pompions, which are herbs of the largest size, are of small durance; whereas hyssop, winter-savoury, germander, thyme, sage, will last long. The cause is, for that trees last according to the strength and quantity of their sap and juice, being well munited by their bark against the injuries of the air; but herbs draw a weak juice and have a soft stalk, and therefore those amongst them which last longest, are herbs of strong smell, and with a sticky stalk.

584. Trees that bear mast, and nuts, are commonly more lasting than those that bear fruits, especially the moister fruits; as oaks, beeches, chestnuts, walnuts, almonds, pine trees, &c. last longer than apples, pears, plums, &c. The cause is the fatness and oiliness of the sap, which ever wasteth less than the more watery.

585. Trees that bring forth their leaves late in the year, and cast them likewise late, are more lasting than those that sprout their leaves early, or shed them betimes. The cause is, for that the late coming forth sheweth a moisture more fixed, and the other loose and more easily resolved. And the same cause is, that wild trees last longer than garden trees; and in the same kind, those whose fruit is acid, more than those whose fruit is sweet.

586. Nothing procureth the lasting of trees, bushes, and herbs, so much as often cutting, for every cutting causeth a renovation of the juice of the plant; that it neither goeth so far, nor riseth so faintly, as when the plant is not cut; insomuch as

annual plants, if you cut them seasonably, and will spare the use of them, and suffer them to come up still young, will last more years than one, as hath been partly touched; such as is lettuce, purslane, cucumber, and the like. And for great trees, we see almost all overgrown trees in church-yards, or near ancient buildings, and the like, are pollards, or dottards, and not trees at their full height.

587. Some experiment would be made, how by art to make plants more lasting than their ordinary period; as to make a stalk of wheat, &c. last a whole year. You must ever presuppose, that you handle it so as the winter killeth it not, for we speak only of prolonging the natural period. I conceive that the rule will hold, that whatsoever maketh the herb come later than at its time, will make it last longer time: it were good to try it in a stalk of wheat, &c. set in the shade, and encompassed with a case of wood, not touching the straw, to keep out open air.

As for the preservation of fruits and plants, as well upon the tree or stalk, as gathered, we shall handle it under the title of conservation of bodies.

Experiments in consort touching the several figures of plants.

588. The particular figures of plants we leave to their descriptions; but some few things in general we will observe. Trees and herbs, in the growing forth of their boughs and branches, are not figured, and keep no order. The cause is, for that the sap

being restrained in the rind and bark, breaketh not forth at all, as in the bodies of trees, and stalks of herbs, till they begin to branch; and then when they make an eruption, they break forth casually, where they find best way in the bark or rind. It is true, that some trees are more scattered in their boughs; as sallow-trees, warden-trees, quince-trees, medlar-trees, lemon-trees, &c. some are more in the form of a pyramis, and come almost to todd; as the pear-tree, which the critics will have to borrow his name of πῦρ fire, orange-trees, fir-trees, service-trees, lime-trees, &c. and some are more spread and broad; as beeches, hornbeam, &c. the rest are more indifferent. The cause of scattering the boughs, is the hasty breaking forth of the sap; and therefore those trees rise not in a body of any height, but branch near the ground. The cause of the pyramis is the keeping in of the sap long before it branch; and the spending of it, when it beginneth to branch, by equal degrees. The spreading is caused by the carrying up of the sap plentifully without expence; and then putting it forth speedily and at once.

589. There be divers herbs, but no trees, that may be said to have some kind of order in the putting forth of their leaves; for they have joints or knuckles, as it were stops in their germination; as have gilly-flowers, pinks, fennel, corn, reeds, and canes. The cause whereof is, for that the sap ascendeth unequally, and doth, as it were, tire and stop by the way. And it seemeth they have some closeness and hardness in their stalk, which hindereth the sap from

going up, until it hath gathered into a knot, and so is more urged to put forth. And therefore they are most of them hollow when the stalk is dry, as fennel-stalk, stubble, and canes.

590. Flowers have all exquisite figures; and the flower numbers are chiefly five, and four; as in primroses, brier-roses, single musk roses, single pinks, and gilly-flowers, &c. which have five leaves: lilies, flower-de-luces, borage, bugloss, &c. which have four leaves. But some put forth leaves not numbered; but they are ever small ones; as marygolds, trefoils, &c. We see also, that the sockets and supporters of flowers are figured; as in the five brethren of the rose, sockets of gilly-flowers, &c. Leaves also are all figured; some round; some long; none square; and many jagged on the sides; which leaves of flowers seldom are. For I account the jagging of pinks and gilly-flowers, to be like the inequality of oak leaves, or vine leaves, or the like: but they seldom or never have any small purls.

Experiments in consort touching some principal differences in plants.

591. Of plants, some few put forth their blossoms before their leaves; as almonds, peaches, cornelians, black thorn, &c. but most put forth some leaves before their blossoms; as apples, pears, plums, cherries, white thorn, &c. The cause is, for that those that put forth their blossoms first, have either an acute and sharp spirit, and therefore commonly they all put forth early in the spring, and ripen very late;

as most of the particulars before mentioned, or else an oily juice, which is apter to put out flowers than leaves.

592. Of plants, some are green all winter; others cast their leaves. There are green all winter, holly, ivy, box, fir, yew, cypress, juniper, bays, rosemary, &c. The cause of the holding green, is the close and compact substance of their leaves, and the pedicles of them. And the cause of that again is either the tough and viscous juice of the plant, or the strength and heat thereof. Of the first sort is holly, which is of so viscous a juice as they make birdlime of the bark of it. The stalk of ivy is tough, and not fragile, as we see in other small twigs dry. Fir, yieldeth pitch. Box is a fast and heavy wood, as we see it in bowls. Yew is a strong and tough wood, as we see it in bows. Of the second sort is juniper, which is a wood odorate, and maketh a hot fire. Bays is likewise a hot and aromatical wood; and so is rosemary for a shrub. As for the leaves, their density appeareth, in that either they are smooth and shining, as in bays, holly, ivy, box, &c. or in that they are hard and spiry, as in the rest. And trial would be made of grafting of rosemary, and bays, and box, upon a holly-stock, because they are plants that come all winter. It were good to try it also with grafts of other trees, either fruit trees, or wild trees, to see whether they will not yield their fruit, or bear their leaves later and longer in the winter; because the sap of the holly putteth forth most in the winter. It may be also a mezerion-tree, grafted

upon a holly, will prove both an earlier and a greater tree.

593. There be some plants that bear no flower and yet bear fruit; there be some that bear flowers and no fruit; there be some that bear neither flowers nor fruit. Most of the great timber trees, as oaks, beeches, &c. bear no apparent flowers; some few likewise of the fruit trees, as mulberry, walnut, &c. and some shrubs, as juniper, holly, &c. bear no flowers. Divers herbs also bear seeds, which is as the fruit, and yet bear no flowers, as purslane, &c. Those that bear flowers and no fruit are few, as the double cherry, the sallow, &c. But for the cherry, it is doubtful whether it be not by art or culture; for if it be by art then trial would be made, whether apples, and other fruits blossoms, may not be doubled. There are some few that bear neither fruit nor flower, as the elm, the poplars, box, brakes, &c.

594. There be some plants that shoot still upwards and can support themselves, as the greatest part of trees and plants; there be some other that creep along the ground, or wind about other trees or props, and cannot support themselves, as vines, ivy, brier, briony, woodbines, hops, clematis, camomile, &c. The cause is, as hath been partly touched, for that all plants naturally move upwards; but if the sap put up too fast, it maketh a slender stalk, which will not support the weight; and therefore these latter sort are all swift and hasty comers.

Experiments in consort touching all manner of composts, and helps of ground.

505. The first and most ordinary help is stercoration. The sheep's dung is one of the best; and next the dung of kine: and thirdly, that of horses, which is held to be somewhat too hot unless it be mingled. That of pigeons for a garden, as a small quantity of ground, excelleth. The ordering of dung is, if the ground be arable, to spread it immediately before the ploughing and sowing; and so to plough it in: for if you spread it long before, the sun will draw out much of the fatness of the dung: if the ground be grazing ground, to spread it somewhat late towards winter; that the sun may have the less power to dry it up. As for special composts for gardens, as a hot bed, &c. we have handled them before.

506. The second kind of compost is, the spreading of divers kinds of earths; as marle, chalk, sea sand, earth upon earth, pond earth; and the mixtures of them. Marle is thought to be the best, as having most fatness; and not heating the ground too much. The next is sea sand, which no doubt obtaineth a special virtue by the salt: for salt is the first rudiment of life. Chalk over-heateth the ground a little; and therefore is best upon cold clay grounds, or moist grounds: but I heard a great husband say that it was a common error, to think that chalk helpeth arable ground, but helpeth not grazing grounds; whereas indeed it helpeth grass

as well as corn: but that which breedeth the error is, because after the chalking of the ground they wear it out with many crops without rest, and then indeed afterwards it will bear little grass, because the ground is tired out. It were good to try the laying of chalk upon arable grounds a little while before ploughing; and to plough it in as they do the dung; but then it must be friable first by rain or lying. As for earth, it composeth itself; for I knew a great garden that had a field, in a manner, poured upon it, and it did bear fruit excellently the first year of the planting: for the surface of the earth is ever the fruitfullest. And earth so prepared hath a double surface. But it is true, as I conceive, that such earth as hath salt-petre bred in it, if you can procure it without too much charge, doth excel. The way to hasten the breeding of salt-petre, is to forbid the sun, and the growth of vegetables. And therefore if you make a large hovel, thatched, over some quantity of ground; nay, if you do but plank the ground over, it will breed salt-petre. As for pond earth, or river earth, it is a very good compost; especially if the pond have been long uncleansed, and so the water be not too hungry: and I judge it will be yet better if there be some mixture of chalk.

597. The third help of ground is, by some other substances that have a virtue to make ground fertile, though they be not merely earth; wherein ashes excel; insomuch as the countries about Ætna and Vesuvius have a kind of amends made them, for the

mischief the irruptions many times do, by the exceeding fruitfulness of the soil, caused by the ashes scattered about. Soot also, though thin spread in a field or garden, is tried to be a very good compost. For salt, it is too costly; but it is tried, that mingled with seed-corn, and sown together, it doth good: and I am of opinion, that chalk in powder, mingled with seed-corn, would do good; perhaps as much as chalking the ground all over. As for the steeping of the seeds in several mixtures with water to give them vigour, or watering grounds with compost-water, we have spoken of them before.

598. The fourth help of ground is, the suffering of vegetables to die into the ground, and so to fatten it; as the stubble of corn, especially peas. Brakes cast upon the ground in the beginning of winter, will make it very fruitful. It were good also to try whether leaves of trees swept together, with some chalk and dung mixed, to give them more heart, would not make a good compost; for there is nothing lost so much as leaves of trees; and as they lie scattered, and without mixture, they rather make the ground sour than otherwise.

599. The fifth help of ground is, heat and warmth. It hath been anciently practised to burn heath, and ling, and sedge, with the vantage of the wind, upon the ground. We see that warmth of walls and inclosures mendeth ground: we see also, that lying open to the south mendeth ground: we see again, that the foldings of sheep help ground, as well by their warmth as by their compost: and it

may be doubted, whether the covering of the ground with brakes in the beginning of the winter, whereof we spake in the last experiment, helpeth it not, by reason of the warmth. Nay, some very good husbands do suspect, that the gathering up of flints in flinty ground, and laying them on heaps, which is much used, is no good husbandry, for that they would keep the ground warm.

600. The sixth help of ground is by watering and irrigation, which is in two manners; the one by letting in and shutting out waters at seasonable times: for water at some seasons, and with reasonable stay, doth good; but at some other seasons, and with too long stay, doth hurt: and this serveth only for meadows which are along some river. The other way is, to bring water from some hanging grounds where there are springs, into the lower grounds, carrying it in some long furrows; and from those furrows, drawing it traverse to spread the water. And this maketh an excellent improvement, both for corn and grass. It is the richer, if those hanging grounds be fruitful, because it washeth off some of the fatness of the earth; but howsoever it profiteth much. Generally where there are great overflows in fens, or the like, the drowning of them in the winter maketh the summer following more fruitful: the cause may be, for that it keepeth the ground warm, and nourisheth it. But the fen-men hold, that the sewers must be kept so as the water may not stay too long in the spring till the weeds and sedge be grown up; for then the ground will be like a

wood, which keepeth out the sun, and so continueth the wet; whereby it will never graze to purpose that year. Thus much for irrigation. But for avoidances, and drainings of water, where there is too much, and the helps of ground in that kind, we shall speak of them in another place.

NATURAL HISTORY.

CENTURY VII.

Experiments in consort touching the affinities and differences between plants and animate bodies.

601. The differences between animate and inanimate bodies, we shall handle fully under the title of life, and living spirits, and powers. We shall therefore make but a brief mention of them in this place. The main differences are two. All bodies have spirits, and pneumatical parts within them: but the main differences between animate and inanimate are two: the first is, that the spirits of things animate are all continued with themselves, and are branched in veins, and secret canals, as blood is: and in living creatures, the spirits have not only branches, but certain cells or seats, where the principal spirits do reside, and whereunto the rest do resort; but the spirits in things inanimate are shut in, and cut off by the tangible parts, and are not pervious one to another, as air is in snow. The second main difference is, that the spirits of animate bodies are all in some degree, more or less, kindled and inflamed; and have a fine commixture of flame, and an aerial substance. But inanimate bodies have their spirits no whit inflamed or kindled. And this difference

consisteth not in the heat or coolness of spirits; for cloves and other spices, naptha and petroleum, have exceeding hot spirits, hotter a great deal than oil, wax, or tallow, &c. but not inflamed. And when any of those weak and temperate bodies come to be inflamed, then they gather a much greater heat than others have uninflamed, besides their light and motion, &c.

602. The differences, which are secondary, and proceed from these two radical differences, are, first, plants are all figurate and determinate, which inanimate bodies are not; for look how far the spirit is able to spread and continue itself, so far goeth the shape of figure, and then is determined. Secondly, plants do nourish, inanimate bodies do not; they have an accretion, but no alimentation. Thirdly, plants have a period of life which inanimate bodies have not. Fourthly, they have a succession and propagation of their kind which is not in bodies inanimate.

603. The differences between plants, and metals or fossils, besides those four before-mentioned, for metals I hold inanimate, are these; first, metals are more durable than plants; secondly, they are more solid and hard; thirdly, they are wholly subterrany; whereas plants are part above earth and part under earth.

604. There be very few creatures that participate of the nature of plants and metals both; coral is one of the nearest of both kinds: another is vitriol, for that is aptest to sprout with moisture.

605. Another special affinity is between plants and mould or putrefaction; for all putrefaction if it dissolve not in arefaction, will in the end issue into plants or living creatures bred of putrefaction. I account moss, and mushrooms, and agaric, and other of those kinds, to be but moulds of the ground, walls, and trees, and the like. As for flesh, and fish, and plants themselves, and a number of other things, after a mouldiness, or rottenness, or corrupting, they will fall to breed worms. These putrefactions, which have affinity with plants, have this difference from them; that they have no succession or propagation, though they nourish, and have a period of life, and have likewise some figure.

606. I left once by chance a citron cut, in a close room, for three summer months that I was absent; and at my return there were grown forth, out of the pith cut, tufts of hairs an inch long, with little black heads, as if they would have been some herb.

Experiments in consort touching the affinities and differences of plants and living creatures, and the confiners and participles of them.

607. The affinities and differences between plants and living creatures are these that follow. They have both of them spirits continued, and branched, and also inflamed. But first in living creatures, the spirits have a cell or seat, which plants have not; as was also formerly said. And secondly, the spirits of living creatures hold more of flame than the spirits

of plants do. And these two are the radical differences. For the secondary differences, they are as follow:—First, plants are all fixed to the earth, whereas all living creatures are severed, and of themselves. Secondly, living creatures have local motion, plants have not. Thirdly, living creatures nourish from their upper parts, by the mouth chiefly; plants nourish from below, namely, from the roots. Fourthly, plants have their seed and seminal parts uppermost; living creatures have them lowermost: and therefore it was said, not elegantly alone, but philosophically; "Homo est planta inversa;" Man is like a plant turned upwards: for the root in plants is as the head in living creatures. Fifthly, living creatures have a more exact figure than plants. Sixthly, living creatures have more diversity of organs within their bodies, and, as it were, inward figures, than plants have. Seventhly, living creatures have sense, which plants have not. Eighthly, living creatures have voluntary motion, which plants have not.

608. For the difference of sexes in plants they are oftentimes by name distinguished, as male-piony, female-piony, male-rosemary, female-rosemary, he-holly, she-holly, &c. but generation by copulation certainly extendeth not to plants. The nearest approach of it is between the he-palm and the she-palm, which, as they report, if they grow near, incline the one to the other, insomuch as, that which is more strange, they doubt not to report, that to keep the trees upright from bending, they tie ropes or lines from the one to the other, that the contact,

might be enjoyed by the contact of a middle body. But this may be feigned, or at least amplified. Nevertheless I am apt enough to think, that this same binarium of a stronger and a weaker, like unto masculine and feminine, doth hold in all living bodies. It is confounded sometimes, as in some creatures of putrefaction, wherein no marks of distinction appear: and it is doubled sometimes, as in hermaphrodites: but generally there is a degree of strength in most species.

609. The participles or confiners between plants and living creatures, are such chiefly as are fixed, and have no local motion of remove, though they have a motion in their parts, such as are oisters, cockles, and such like. There is a fabulous narration, that in the northern countries there should be an herb that groweth in the likeness of a lamb, and feedeth upon the grass, in such sort as it will bare the grass round about. But I suppose that the figure maketh the fable; for so, we see, there be bee-flowers, &c. And as for the grass, it seemeth the plant having a great stalk and top doth prey upon the grass a good way about, by drawing the juice of the earth from it.

Experiments promiscuous touching plants.

610. The Indian fig boweth its roots down so low in one year, as of itself it taketh root again, and so multiplieth from root to root, making of one tree a kind of wood. The cause is the plenty of the sap, and the softness of the stalk; which maketh the bough, being over-loaden, and not stiffly upheld, weigh down. It hath leaves as broad as a little

target, but the fruit no bigger than beans. The cause is, for that the continual shade increaseth the leaves, and abateth the fruit, which nevertheless is of a pleasant taste. And that no doubt is caused by the suppleness and gentleness of the juice of that plant, being that which maketh the boughs also so flexible.

611. It is reported by one of the ancients, that there is a certain Indian tree, having few but very great leaves, three cubits long and two broad, and that the fruit, being of good taste, groweth out of the bark. It may be, there be plants that pour out the sap so fast, as they have no leisure either to divide into many leaves, or to put forth stalks to the fruit. With us, trees, generally, have small leaves in comparison. The fig hath the greatest; and next it the vine, mulberry, and sycamore, and the least are those of the willow, birch, and thorn. But there be found herbs with far greater leaves than any tree; as the bur, gourd, cucumber, and colewort. The cause is, like to that of the Indian fig, the hasty and plentiful putting forth of the sap.

612. There be three things in use for sweetness; sugar, honey, manna. For sugar, to the ancients it was scarce known, and little used. It is found in canes: *Query*, whether to the first knuckle, or further up? And whether the very bark of the cane itself do yield sugar, or no? For honey, the bee maketh it, or gathereth it; but I have heard from one that was industrious in husbandry, that the labour of the bee is about the wax; and that he

hath known in the beginning of May honeycombs empty of honey; and within a fortnight, when the sweet dews fall, filled like a cellar. It is reported also by some of the ancients, that there is a tree called occhus, in the valleys of Hyrcania, that distilleth honey in the mornings. It is not unlike that the sap and tears of some trees may be sweet. It may be also, that some sweet juices, fit for many uses, may be concocted out of fruits, to the thickness of honey, or perhaps of sugar; the likeliest are raisins of the sun, figs, and currants; the means may be inquired.

613. The ancients report of a tree by the Persian sea, upon the shore sands, which is nourished with the salt water; and when the tide ebbeth, you shall see the roots as it were bare without bark, being as it seemeth corroded by the salt, and grasping the sands like a crab; which nevertheless beareth a fruit. It were good to try some hard trees, as a service-tree, or fir-tree, by setting them within the sands.

614. There be of plants which they use for garments, these that follow: hemp, flax, cotton, nettles, whereof they make nettle-cloth, sericum, which is a growing silk; they make also cables of the bark of lime trees. It is the stalk that maketh the filaceous matter commonly; and sometimes the down that groweth above.

615. They have in some countries, a plant of a rosy colour, which shutteth in the night, openeth in the morning, and openeth wide at noon; which the

inhabitants of those countries say is a plant that sleepeth. There be sleepers enough then; for almost all flowers do the like.

616. Some plants there are, but rare, that have a mossy or downy root; and likewise that have a number of threads, like beards, as mandrakes, whereof witches and impostors make an ugly image, giving it the form of a face at the top of the root, and leaving those strings to make a broad beard down to the foot. Also there is a kind of nard in Crete, being a kind of phu, that hath a root hairy, like a rough-footed dove's foot. So as you may see, there are of roots, bulbous roots, fibrous roots, and hirsute roots. And, I take it, in the bulbous, the sap hasteneth most to the air and sun, in the fibrous, the sap delighteth more in the earth, and therefore putteth downward, and the hirsute is a middle between both, that besides the putting forth upwards and downwards, putteth forth in round.

617. There are some tears of trees, which are combed from the beards of goats: for when the goats bite and crop them, especially in the mornings, the dew being on, the tear cometh forth, and hangeth upon their beards: of this sort is some kind of laudanum.

618. The irrigation of the plane-tree by wine, is reported by the ancients to make it fruitful. It would be tried likewise with roots; for upon seeds it worketh no great effects.

619. The way to carry foreign roots a long way, is to vessel them close in earthen vessels. But if the

vessels be not very great, you must make some holes in the bottom, to give some refreshment to the roots; which otherwise, as it seemeth, will decay and suffocate.

620. The ancient cinnamon was, of all other plants, while it grew, the driest, and those things which are known to comfort other plants, did make that more steril; for in showers it prospered worst; it grew also amongst bushes of other kinds, where commonly plants do not thrive, neither did it love the sun. There might be one cause of all those effects; namely, the sparing nourishment which that plant required. *Query*, how far cassia, which is now the substitute of cinnamon, doth participate of these things?

621. It is reported by one of the ancients, that cassia, when it is gathered, is put into the skins of beasts newly flayed; and that the skins corrupting and breeding worms, the worms do devour the pith and marrow of it, and so make it hollow, but meddle not with the bark, because to them it is bitter.

622. There were in ancient time vines of far greater bodies than we know any, for there have been cups made of them, and an image of Jupiter. But it is like they were wild vines; for the vines that they use for wine, are so often cut, and so much digged and dressed, that their sap spendeth into the grapes, and so the stalk cannot increase much in bulk. The wood of vines is very durable, without rotting. And that which is strange, though no tree hath the twigs, while they are green, so brittle, yet the wood

dried is extreme tough, and was used by the captains of armies amongst the Romans for their cudgels.

623. It is reported, that in some places vines are suffered to grow like herbs, spreading upon the ground, and that the grapes of those vines are very great. It were good to make trial, whether plants that use to be borne up by props, will not put forth greater leaves and greater fruits if they be laid along the ground; as hops, ivy, woodbine, &c.

624. Quinces, or apples, &c. if you will keep them long, drown them in honey; but because honey, perhaps, will give them a taste over-luscious, it were good to make trial in powder of sugar, or in syrup of wine, only boiled to height. Both these would likewise be tried in oranges, lemons, and pomegranates; for the powder of sugar, and syrup of wine, will serve for more times than once.

625. The conservation of fruit would be also tried in vessels filled with fine sand, or with powder of chalk; or in meal and flour; or in dust of oak wood; or in mill.

626. Such fruits as you appoint for long keeping, you must gather before they be full ripe; and in a fair and dry day towards noon; and when the wind bloweth not south; and when the moon is under the earth, and in decrease.

627. Take grapes, and hang them in an empty vessel well stopped; and set the vessel not in a cellar, but in some dry place, and it is said they will last long. But it is reported by some, they will

keep better in a vessel half full of wine, so that the grapes touch not the wine.

628. It is reported, that the preserving of the stalk helpeth to preserve the grape; especially if the stalk be put into the pith of elder, the elder not touching the fruit.

629. It is reported by some of the ancients, that fruit put in bottles, and the bottles let down into wells under water, will keep long.

630. Of herbs and plants, some are good to eat raw; as lettuce, endive, purslane, tarragon, cresses, cucumbers, musk-melons, radish, &c. others only after they are boiled, or have passed the fire; as parsley, clary, sage, parsnips, turnips, asparagus, artichokes, though they also being young are eaten raw: but a number of herbs are not esculent at all; as wormwood, grass, green corn, centaury, hyssop, lavender, balm, &c. The causes are, for that the herbs that are not esculent, do want the two tastes in which nourishment resteth; which are fat and sweet; and have, contrariwise, bitter and over-strong tastes, or a juice so crude as cannot be ripened to the degree of nourishment. Herbs and plants that are esculent raw, have fatness, or sweetness, as all esculent fruits; such are onions, lettuce, &c. But then it must be such a fatness, (for as for sweet things, they are in effect always esculent,) as is not over-gross, and loading of the stomach: for parsnips and leeks have fatness, but it is too gross and heavy without boiling. It must be also in a substance somewhat tender; for

we see wheat, barley, artichokes, are no good nourishment till they have passed the fire; but the fire doth ripen, and maketh them soft and tender, and so they become esculent. As for radish and tarragon, and the like, they are for condiments, and not for nourishment. And even some of those herbs which are not esculent, are notwithstanding poculent; as hops, broom, &c. *Query*, what herbs are good for drink besides the two aforenamed; for that it may, perhaps, ease the charge of brewing, if they make beer to require less malt, or make it last longer.

631. Parts fit for the nourishment of man in plants are, seeds, roots, and fruits; but chiefly seeds and roots. For leaves, they give no nourishment at all, or very little: no more do flowers, or blossoms, or stalks. The reason is, for that roots, and seeds, and fruits, inasmuch as all plants consist of an oily and watery substance commixed, have more of the oily substance, and leaves, flowers, &c. of the watery. And secondly, they are more concocted; for the root which continueth ever in the earth, is still concocted by the earth; and fruits and grains we see are half a year or more in concocting; whereas leaves are out and perfect in a month.

632. Plants, for the most part, are more strong both in taste and smell in the seed, than in the leaf and root. The cause is, for that in plants that are not of a fierce and eager spirit, the virtue is increased by concoction and maturation, which is ever most in the seed; but in plants that are of a fierce and eager

spirit, they are stronger whilst the spirit is inclosed in the root, and the spirits do but weaken and dissipate when they come to the air and sun; as we see it in onions, garlick, dragon, &c. Nay, there be plants that have their roots very hot and aromatical, and their seeds rather insipid, as ginger. The cause is, as was touched before, for that the heat of those plants is very dissipable; which under the earth is contained and held in; but when it cometh to the air it exhaleth.

633. The juices of fruits are either watery or oily. I reckon among the watery, all the fruits out of which drink is expressed; as the grape, the apple, the pear, the cherry, the pomegranate, &c. And there are some others which, though they be not in use for drink, yet they appear to be of the same nature; as plums, services, mulberries, rasps, oranges, lemons, &c. and for those juices that are so fleshy, as they cannot make drink by expression, yet, perhaps, they may make drink by mixture of water.

Poculaque admistis imitantur vitea sorbis.

And it may be hips and brier-berries would do the like. Those that have oily juice, are olives, almonds, nuts of all sorts, pine-apples, &c. and their juices are all inflammable. And you must observe also, that some of the watery juices, after they have gathered spirit, will burn and inflame; as wine. There is a third kind of fruit that is sweet, without either sharpness or oiliness: such as is the fig and the date.

634. It hath been noted, that most trees, and

specially those that bear mast, are fruitful but once in two years. The cause, no doubt, is the expence of sap; for many orchard trees, well cultured, will bear divers years together.

635. There is no tree, which besides the natural fruit doth bear so many bastard fruits as the oak doth: for besides the acorn, it beareth galls, oak apples, and certain oak nuts, which are inflammable, and certain oak berries, sticking close to the body of the tree without stalk. It beareth also misseltoe, though rarely. The cause of all these may be, the closeness and solidness of the wood, and pith of the oak, which maketh several juices find several eruptions. And therefore if you will devise to make any super-plants, you must ever give the sap plentiful rising and hard issue.

636. There are two excrescences which grow upon trees; both of them in the nature of mushrooms: the one the Romans call boletus; which groweth upon the roots of oaks, and was one of the dainties of their table; the other is medicinal, that is called agaric, whereof we have spoken before, which groweth upon the tops of oaks; though it be affirmed by some, that it groweth also at the roots. I do conceive, that many excrescences of trees grow chiefly where the tree is dead or faded; for that the natural sap of the tree corrupteth into some preternatural substance.

637. The greater part of trees bear most and best on the lower boughs; as oaks, figs, walnuts, pears, &c. but some bear best on the top boughs, as

crabs, &c. Those that bear best below, are such as shade doth more good to than hurt. For generally all fruits bear best lowest, because the sap tireth not, having but a short way: and therefore in fruits spread upon walls, the lowest are the greatest, as was formerly said: so it is the shade that hindereth the lower boughs, except it be in such trees as delight in shade, or at least bear it well. And therefore they are either strong trees, as the oak, or else they have large leaves, as the walnut and fig, or else they grow in pyramis, as the pear. But if they require very much sun, they bear best on the top, as it is in crabs, apples, plums, &c.

638. There be trees that bear best when they begin to be old, as almonds, pears, vines, and all trees that give mast. The cause is, for that all trees that bear mast, have an oily fruit, and young trees have a more watery juice, and less concocted, and of the same kind also is the almond. The pear likewise, though it be not oily, yet it requireth much sap, and well concocted, for we see it is a heavy fruit and solid, much more than apples, plums, &c. As for the vine, it is noted, that it beareth more grapes when it is young; but grapes that make better wine when it is old; for that the juice is better concocted; and we see that wine is inflammable, so as it hath a kind of oiliness. But the most part of trees, amongst which are apples, plums, &c. bear best when they are young.

639. There be plants that have a milk in them when they are cut, as figs, old lettuce, sow-thistles,

spurge, &c. The cause may be an inception of putrefaction: for those milks have all an acrimony: though one would think they should be lenitive. For if you write upon paper with the milk of the fig, the letters will not be seen, until you hold the paper before the fire, and then they wax brown: which sheweth that it is a sharp or fretting juice: lettuce is thought poisonous, when it is so old as to have milk; spurge is a kind of poison in itself, and as for sow thistles, though coneys eat them, yet sheep and cattle will not touch them: and besides, the milk of them rubbed upon warts, in short time weareth them away; which sheweth the milk of them to be corrosive. We see also that wheat and other corn, sown, if you take them forth of the ground before they sprout, are full of milk, and the beginning of germination is ever a kind of putrefaction of the seed. Euphorbium also hath a milk, though not very white, which is of a great acrimony: and salladine hath a yellow milk, which hath likewise much acrimony; for it cleanseth the eyes. It is good also for cataracts.

640. Mushrooms are reported to grow, as well upon the bodies of trees, as upon their roots, or upon the earth; and especially upon the oak. The cause is, for that strong trees are towards such excrescences in the nature of earth; and therefore put forth moss, mushrooms, and the like.

641. There is hardly found a plant that yieldeth a red juice in the blade or ear; except it be the tree that beareth sanguis draconis; which groweth chiefly

in the island Socotra: the herb amaranthus indeed is red all over; and brazil is red in the wood: and so is red sanders. The tree of the sanguis draconis groweth in the form of a sugar-loaf. It is like that the sap of that plant concocteth in the body of the tree. For we see that grapes and pomegranates are red in the juice, but are green in the tear: and this maketh the tree of sanguis draconis lesser towards the top; because the juice hasteneth not up; and besides, it is very astringent; and therefore of slow motion.

642. It is reported, that sweet moss, besides that upon the apple trees, groweth likewise sometimes upon poplars; and yet generally the poplar is a smooth tree of bark, and hath little moss. The moss of the larix-tree burneth also sweet, and sparkleth in the burning. *Query* of the mosses of odorate trees; as cedar, cypress, lignum aloës, &c.

643. The death that is most without pain, hath been noted to be upon the taking of the potion of hemlock; which in humanity was the form of execution of capital offenders in Athens. The poison of the asp, that Cleopatra used, hath some affinity with it. The cause is, for that the torments of death are chiefly raised by the strife of the spirits; and these vapours quench the spirits by degrees; like to the death of an extreme old man. I conceive it is less painful than opium, because opium hath parts of heat mixed.

644. There be fruits that are sweet before they be ripe, as myrobalanes; so fennel seeds are sweet before they ripen, and after grow spicy. And some

never ripen to be sweet; as tamarinds, berberries, crabs, sloes, &c. The cause is, for that the former kind have much and subtle heat, which causeth early sweetness; the latter have a cold and acid juice, which no heat of the sun can sweeten. But as for the myrobalane, it hath parts of contrary natures; for it is sweet and and yet astringent.

645. There be few herbs that have a salt taste; and contrariwise all blood of living creatures hath a saltness. The cause may be, for that salt, though it be the rudiment of life, yet in plants the original taste remaineth not; for you shall have them bitter, sour, sweet, biting, but seldom salt; but in living creatures, all those high tastes may happen to be sometimes in the humours, but are seldom in the flesh or substance, because it is of a more oily nature; which is not very susceptible of those tastes, and the saltness itself of blood is but a light and secret saltness: and even among plants, some do participate of saltness, as alga marina, samphire, scurvy grass, &c. And they report, there is in some of the Indian seas a swimming plant, which they call salgazus, spreading over the sea in such sort, as one would think it were a meadow. It is certain, that out of the ashes of all plants they extract a salt which they use in medicines.

646. It is reported by one of the ancients, that there is an herb growing in the water, called lincostis, which is full of prickles: this herb putteth forth another small herb out of the leaf; which is

imputed to some moisture that is gathered between the prickles, which putrified by the sun germinateth. But I remember also I have seen, for a great rarity, one rose grow out of another like honeysuckles, that they call top and top-gallants.

647. Barley, as appeareth in the malting, being steeped in water three days, and afterwards the water drained from it, and the barley turned upon a dry floor, will sprout half an inch long at least: and if it be let alone, and not turned, much more; until the heart be out. Wheat will do the same. Try it also with peas and beans. This experiment is not like that of the orpine and semper-vive, for there it is of the old store, for no water is added; but here it is nourished from the water. The experiment would be farther driven: for it appeareth already, by that which hath been said, that earth is not necessary to the first sprouting of plants, and we see that rose-buds set in water will blow: therefore try whether the sprouts of such grains may not be raised to a farther degree, as to an herb, or flower, with water only, or some small commixture of earth: for if they will, it should seem by the experiments before, both of the malt and of the roses, that they will come far faster on in water than in earth; for the nourishment is easilier drawn out of water than out of earth. It may give some light also, that drink infused with flesh, as that with the capon, &c. will nourish faster and easilier than meat and drink together. Try the same experiment

with roots as well as with grains: as for example, take a turnip, and steep it a while, and then dry it, and see whether it will sprout.

648. Malt in the drenching will swell; and that in such a manner, as after the putting forth in sprouts, and the drying upon the kiln, there will be gained at least a bushel in eight, and yet the sprouts are rubbed off, and there will be a bushel of dust besides the malt, which I suppose to be, not only by the loose and open lying of the parts, but by some addition of substance drawn from the water in which it was steeped.

649. Malt gathereth a sweetness to the taste, which appeareth yet more in the wort. The dulcoration of things is worthy to be tried to the full: for that dulcoration importeth a degree to nourishment: and the making of things inalimental to become alimental, may be an experiment of great profit for making new victual.

650. Most seeds in the growing, leave their husk or rind about the root; but the onion will carry it up, that it will be like a cap upon the top of the young onion. The cause may be, for that the skin or husk is not easy to break; as we see by the pilling of onions, what a holding substance the skin is.

651. Plants, that have curled leaves, do all abound with moisture; which cometh so fast on, as they cannot spread themselves plain, but must needs gather together. The weakest kind of curling is roughness, as in clary and burr. The second is

curling on the sides; as in lettuce, and young cabbage: and the third is folding into an head; as in cabbage full grown, and cabbage-lettuce.

652. It is reported, that fir and pine, especially if they be old and putrified, though they shine not as some rotten woods do, yet in the sudden breaking they will sparkle like hard sugar.

653. The roots of trees do some of them put downwards deep into the ground; as the oak, pine, fir, &c. Some spread more toward the surface of the earth; as the ash, cypress-tree, olive, &c. The cause of this latter may be, for that such trees as love the sun, do not willingly descend far into the earth, and therefore they are, commonly, trees that shoot up much; for in their body their desire of approach to the sun maketh them spread the less. And the same reason under ground, to avoid recess from the sun, maketh them spread the more. And we see it cometh to pass in some trees which have been planted too deep in the ground, that for love of approach to the sun, they forsake their first root, and put out another more towards the top of the earth. And we see also, that the olive is full of oily juice; and ash maketh the best fire, and cypress is an hot tree. As for the oak, which is of the former sort, it loveth the earth, and therefore groweth slowly. And for the pine and fir likewise, they have so much heat in themselves, as they need less the heat of the sun. There be herbs also that have the same difference; as the herb they call morsus diaboli; which putteth forth the root down so low, as you

cannot pull it up without breaking; which gave occasion to the name and fable; for that it was said, it was so wholesome a root, that the devil, when it was gathered, bit it for envy: and some of the ancients do report, that there was a goodly fir, which they desired to remove the whole, that had a root under ground eight cubits deep; and so the root came up broken.

654. It hath been observed, that a branch of a tree, being unbarked some space at the bottom, and so set into the ground, hath grown; even of such trees, as if the branch were set with the bark on, they would not grow; yet contrariwise we see, that a tree pared round in the body above ground, will die. The cause may be, for that the unbarked part draweth the nourishment best, but the bark continueth it only.

655. Grapes will continue fresh and moist all winter long, if you hang them cluster by cluster in the roof of a warm room; especially if when you gather the cluster, you take off with the cluster some of the stock.

656. The reed or cane is a watery plant, and groweth not but in the water: it hath these properties: that it is hollow, that it is knuckled both stalk and root, that being dry, it is more hard and fragile than other wood, that it putteth forth no boughs, though many stalks come out of one root. It differeth much in greatness, the smallest being fit for thatching of houses, and stopping the chinks of ships, better than glue or pitch. The second big-

ness is used for angle-rods and staves; and in China for beating of offenders upon the thighs. The differing kinds of them are, the common reed, the cassia fistula, and the sugar-reed. Of all plants it boweth the easiest, and riseth again. It seemeth, that amongst plants which are nourished with mixture of earth and water, it draweth most nourishment from water; which maketh it the smoothest of all others in bark, and the hollowest in body.

657. The sap of trees when they are let blood, is of differing natures. Some more watery and clear, as that of vines, of beeches, of pears: some thick, as apples: some gummy, as cherries: some frothy, as elms: some milky, as figs. In mulberries the sap seemeth to be almost towards the bark only, for if you cut the tree a little into the bark with a stone, it will come forth; if you pierce it deeper with a tool, it will be dry. The trees which have the moistest juices in their fruit, have commonly the moistest sap in their body, for the vines and pears are very moist; apples somewhat more spungy: the milk of the fig hath the quality of the rennet, to gather cheese; and so have certain sour herbs wherewith they make cheese in Lent.

658. The timber and wood are in some trees more clean, in some more knotty, and it is a good trial to try it by speaking at one end, and laying the ear at the other: for if it be knotty, the voice will not pass well. Some have the veins more varied and chambletted, as oak, whereof wainscot is made; maple, whereof trenchers are made: some more

smooth, as fir and walnut: some do more easily breed worms and spiders, some more hardly, as it is said of Irish trees: besides there be a number of differences that concern their use; as oak, cedar, and chesnut, are the best builders; some are best for plough-timber, as ash; some for piers, that are sometimes wet and sometimes dry, as elm; some for planchers, as deal; some for tables, cupboards, and desks, as walnuts; some for ship timber, as oaks that grow in moist grounds, for that maketh the timber tough, and not apt to rift with ordnance; wherein English and Irish timber are thought to excel: some for masts of ships, as fir and pine, because of their length, straightness, and lightness: some for pale, as oak; some for fuel, as ash, and so of the rest.

659. The coming of trees and plants in certain regions, and not in others, is sometimes casual: for many have been translated, and have prospered well; as damask-roses, that have not been known in England above an hundred years and now are so common. But the liking of plants in certain soils more than in others, is merely natural, as the fir and pine love the mountains; the poplar, willow, sallow, and alder, love rivers and moist places; the ash loveth coppices, but is best in standards alone; juniper loveth chalk, and so do most fruit trees; samphire groweth but upon rocks; reeds and osiers grow where they are washed with water: the vine loveth sides of hills, turning upon the south-east sun, &c.

660. The putting forth of certain herbs discovereth of what nature the ground where they put forth is, as wild thyme sheweth good feeding-ground for cattle; betony and strawberries shew grounds fit for wood; camomile sheweth mellow grounds fit for wheat. Mustard-seed, growing after the plough, sheweth a good strong ground also for wheat: burnet sheweth good meadow, and the like.

661. There are found in divers countries, some other plants that grow out of trees and plants, besides misseltoe: as in Syria there is an herb called cassytas, that groweth out of tall trees, and windeth itself about the same tree where it groweth, and sometimes about thorns. There is a kind of polypode that groweth out of trees, though it windeth not. So likewise an herb called faunos, upon the wild olive. And an herb called hippophæston upon the fullers thorn: which, they say, is good for the falling sickness.

662. It hath been observed by some of the ancients, that howsoever cold and easterly winds are thought to be great enemies to fruit, yet nevertheless south winds are also found to do hurt, especially in the blossoming time, and the more if showers follow. It seemeth they call forth the moisture too fast. The west winds are the best. It hath been observed also, that green and open winters do hurt trees, insomuch as if two or three such winters come together almond-trees, and some other trees, will die. The cause is the same with the former, because

the lust of the earth over-spendeth itself: howsoever some other of the ancients have commended warm winters.

663. Snows lying long cause a fruitful year; for first they keep in the strength of the earth; secondly, they water the earth better than rain: for in snow, the earth doth, as it were, suck the water as out of the teat: thirdly, the moisture of snow is the finest moisture, for it is the froth of the cloudy waters.

664. Showers, if they come a little before the ripening of fruits, do good to all succulent and moist fruits; as vines, olives, pomegranates; yet it is rather for plenty than for goodness; for the best wines are in the driest vintages: small showers are likewise good for corn, so as parching heats come not upon them. Generally night showers are better than day showers, for that the sun followeth not so fast upon them; and we see even in watering by the hand, it is best in summer time to water in the evening.

665. The differences of earths, and the trial of them, are worthy to be diligently inquired. The earth, that with showers doth easiliest soften, is commended; and yet some earth of that kind will be very dry and hard before the showers. The earth that casteth up from the plough a great clod, is not so good as that which casteth up a smaller clod. The earth that putteth forth moss easily, and may be called mouldy, is not good. The earth that smelleth well upon the digging, or ploughing, is commended, as containing the juice of vegetables almost already

prepared. It is thought by some, that the ends of low rainbows fall more upon one kind of earth than upon another, as it may well be; for that that earth is most roscid: and therefore it is commended for a sign of good earth. The poorness of the herbs, it is plain, shew the poorness of the earth; and especially if they be in colour more dark: but if the herbs shew withered, or blasted at the top, it sheweth the earth to be very cold; and so doth the mossiness of trees. The earth, whereof the grass is soon parched with the sun, and toasted, is commonly forced earth, and barren in its own nature. The tender, chessome, and mellow earth, is the best, being mere mould, between the two extremes of clay and sand, especially if it be not loamy and binding. The earth, that after rain will scarce be ploughed, is commonly fruitful: for it is cleaving, and full of juice.

666. It is strange, which is observed by some of the ancients, that dust helpeth the fruitfulness of trees, and of vines by name; insomuch as they cast dust upon them of purpose. It should seem, that that powdering, when a shower cometh, maketh a kind of soiling to the tree, being earth and water finely laid on. And they note, that countries where the fields and ways are dusty bear the best vines.

667. It is commended by the ancients for an excellent help to trees, to lay the stalks and leaves of lupins about the roots, or to plough them into the ground where you will sow corn. The burning also of the cuttings of vines, and casting them upon

land, doth much good. And it was generally received of old, that dunging of grounds when the west wind bloweth, and in the decrease of the moon, doth greatly help; the earth, as it seemeth, being then more thirsty and open to receive the dung.

668. The grafting of vines upon vines, as I take it, is not now in use: the ancients had it, and that three ways: the first was incision, which is the ordinary manner of grafting: the second was terebration through the middle of the stock, and putting in the cions there: and the third was paring of two vines that grow together to the marrow, and binding them close.

669. The diseases and ill accidents of corn are worthy to be inquired; and would be more worthy to be inquired, if it were in men's power to help them, whereas many of them are not to be remedied. The mildew is one of the greatest, which, out of question, cometh by closeness of air; and therefore in hills, or large champain grounds, it seldom cometh; such as is with us York's woald. This cannot be remedied, otherwise than that in countries of small inclosure the grounds be turned into larger fields: which I have known to do good in some farms. Another disease is the putting forth of wild oats, whereinto corn oftentimes, especially barley, doth degenerate. It happeneth chiefly from the weakness of the grain that is sown; for if it be either too old or mouldy, it will bring forth wild oats. Another disease is the satiety of the ground; for if you sow one ground still with the same corn, I mean

not the same corn that grew upon the same ground, but the same kind of grain, as wheat, barley, &c. it will prosper but poorly: therefore, besides the resting of the ground, you must vary the seed. Another ill accident is from the winds, which hurt at two times; at the flowering, by shaking off the flowers, and at the full ripening, by shaking out the corn. Another ill accident is drought, at the spindling of the corn, which with us is rare, but in hotter countries common: insomuch as the word calamitas was first derived from calamus, when the corn could not get out of the stalk. Another ill accident is overwet at sowing time, which with us breedeth much dearth, insomuch as the corn never cometh up; and many times they are forced to resow summer corn where they sowed winter corn. Another ill accident is bitter frosts continued without snow, especially in the beginning of the winter, after the seed is new sown. Another disease is worms, which sometimes breed in the root, and happen upon hot suns and showers immediately after the sowing; and another worm breedeth in the ear itself, especially when hot suns break often out of clouds. Another disease is weeds, and they are such as either choke and overshadow the corn, and bear it down, or starve the corn, and deceive it of nourishment. Another disease is over-rankness of the corn; which they use to remedy by mowing it after it is come up, or putting sheep into it. Another ill accident is laying of corn with great rains, near or in harvest. Another ill accident is, if the seed happen to have touched oil, or

any thing that is fat; for those substances have an antipathy with nourishment of water.

670. The remedies of the diseases of corn have been observed as followeth. The steeping of the grain, before sowing, a little time in wine, is thought a preservative: the mingling of seed corn with ashes is thought to be good: the sowing at the wane of the moon, is thought to make the corn sound: it hath not been practised, but it is thought to be of use to make some miscellane in corn, as if you sow a few beans with wheat, your wheat will be the better. It hath been observed that the sowing of corn with housleek doth good. Though grain that toucheth oil or fat, receiveth hurt, yet the steeping of it in the dregs of oil, when it beginneth to putrify, which they call amurca, is thought to assure it against worms. It is reported also, that if corn be mowed, it will make the grain longer, but emptier, and having more of the husk.

671. It hath been noted, that seed of a year old is the best, and of two or three years is worse, and that which is more old is quite barren; though, no doubt, some seeds and grains last better than others. The corn which in the vanning lieth lowest is the best: and the corn which broken or bitten retaineth a little yellowness, is better than that which is very white.

672. It hath been observed, that of all roots of herbs, the root of sorrel goeth the farthest into the earth; insomuch that it hath been known to go three

cubits deep: and that it is the root that continueth fit longest to be set again, of any root that groweth. It is a cold and acid herb, that, as it seemeth, loveth the earth, and is not much drawn by the sun.

673. It hath been observed, that some herbs like best being watered with salt water: as radish, beet, rue, pennyroyal; this trial would be extended to some other herbs; especially such as are strong, as tarragon, mustard-seed, rocket, and the like.

674. It is strange that is generally received, how some poisonous beasts affect odorate and wholesome herbs; as that the snake loveth fennel; that the toad will be much under sage: that frogs will be in cinque-foil. It may be it is rather the shade, or other coverture, that they take liking in, than the virtue of the herb.

675. It were a matter of great profit, save that I doubt it is too conjectural to venture upon, if one could discern what corn, herbs, or fruits, are like to be in plenty or scarcity, by some signs and prognostic in the beginning of the year: for as for those that are like to be in plenty, they may be bargained for upon the ground; as the old relation was of Thales, who, to shew how easy it was for a philosopher to be rich, when he foresaw a great plenty of olives, made a monopoly of them. And for scarcity, men may make profit in keeping better the old store. Long continuance of snow is believed to make a fruitful year of corn: an early winter, or a very late winter, a barren year of corn: an open and serene winter,

an ill year of fruit: these we have partly touched before: but other prognostics of like nature are diligently to be inquired.

676. There seem to be in some plants singularities, wherein they differ from all other; the olive hath the oily part only on the outside; whereas all other fruits have it in the nut or kernel. The fir hath, in effect, no stone, nut, nor kernel, except you will count the little grains kernels. The pomegranate and pine-apple have only amongst fruits grains distinct in several cells. No herbs have curled leaves but cabbage and cabbage-lettuce. None have doubled leaves, one belonging to the stalk, another to the fruit or seed, but the artichoke. No flower hath that kind of spread that the woodbine hath. This may be a large field of contemplation; for it sheweth that in the frame of nature, there is, in the producing of some species, a composition of matter, which happeneth oft, and may be much diversified: in others, such as happeneth rarely, and admitteth little variety: for so it is likewise in beasts: dogs have a resemblance with wolves and foxes; horses with asses, kine with buffles, hares with coneys, &c. And so in birds: kites and kestrels have a resemblance with hawks; common doves with ring-doves and turtles; blackbirds with thrushes and mavises; crows with ravens, daws, and choughs, &c. But elephants and swine amongst beasts; and the bird of paradise and the peacock amongst birds; and some few others, have scarce any other species that have affinity with them.

We leave the description of plants, and their virtues, to herbals, and other like books of natural history, wherein men's diligence hath been great, even to curiosity: for our experiments are only such as do ever ascend a degree to the deriving of causes, and extracting of axioms, which we are not ignorant but that some both of the ancient and modern writers have also laboured; but their causes and axioms are so full of imagination, and so infected with the old received theories, as they are mere inquinations of experience, and concoct it not.

Experiment solitary touching healing of wounds.

677. It hath been observed by some of the ancients, that skins, especially of rams, newly pulled off, and applied to the wounds of stripes, do keep them from swelling and exulcerating, and likewise heal them and close them up; and that the whites of eggs do the same. The cause is a temperate conglutination, for both bodies are clammy and viscous, and do bridle the deflux of humours to the hurts, without penning them in too much.

Experiment solitary touching fat diffused in flesh.

678. You may turn almost all flesh into a fatty substance, if you take flesh and cut it into pieces, and put the pieces into a glass covered with parchment, and so let the glass stand six or seven hours in boiling water. It may be an experiment of profit for making of fat or grease for many uses; but then it must be of such flesh as is not edible; as horses, dogs, bears, foxes, badgers, &c.

Experiment solitary touching ripening of drink before the time.

679. It is reported by one of the ancients, that new wine put into vessels well stopped, and the vessels let down into the sea, will accelerate very much the making of them ripe and potable. The same would be tried in wort.

Experiment solitary touching pilosity and plumage.

680. Beasts are more hairy than men, and savage men more than civil, and the plumage of birds exceedeth the pilosity of beasts. The cause of the smoothness in men is not any abundance of heat and moisture, though that indeed causeth pilosity; but there is requisite to pilosity, not so much heat and moisture, as excrementitious heat and moisture; for whatsoever assimilateth, goeth not into the hair, and excrementitious moisture aboundeth most in beasts, and men that are more savage. Much the same reason is there of the plumage of birds, for birds assimilate less, and excern more than beasts for their excrements are ever liquid, and their flesh generally more dry: besides, they have not instruments for urine; and so all the excrementitious moisture goeth into the feathers: and therefore it is no marvel, though birds be commonly better meat than beasts because their flesh doth assimilate more finely, and secerneth more subtilly. Again, the head of man hath hair upon the first birth, which no other part of the body hath. The cause may be want of perspi-

ration; for much of the matter of hair, in the other parts of the body, goeth forth by insensible perspiration, and besides, the skull being of a more solid substance, nourisheth and assimilateth less, and excerneth more, and so likewise doth the chin. We see also, that hair cometh not upon the palms of the hands, nor soles of the feet; which are parts more perspirable. And children likewise are not hairy, for that their skins are more perspirable.

Experiment solitary touching the quickness of motion in birds.

681. Birds are of swifer motion than beasts; for the flight of many birds is swifter than the race of any beasts. The cause is, for that the spirits in birds are in greater proportion, in comparison of the bulk of their body, than in beasts: for as for the reason that some give, that they are partly carried, whereas beasts go, that is nothing, for by that reason swimming should be swifter than running: and that kind of carriage also is not without labour of the wing.

Experiment solitary touching the different clearness of the sea.

682. The sea is clearer when the north wind bloweth, that when the south wind. The cause is, for that salt water hath a little oiliness in the surface thereof, as appeareth in very hot days: and again, for that the southern wind relaxeth the water somewhat; as no water boiling is so clear as cold water.

Experiment solitary touching the different heats of fire and boiling water.

683. Fire burneth wood, making it first luminous, then black and brittle, and lastly, broken and incinerate: scalding water doth none of these. The cause is, for that by fire the spirit of the body is first refined, and then emitted; whereof the refining or attenuation causeth the light, and the emission, first the fragility, and after the dissolution into ashes; neither doth any other body enter: but in water the spirit of the body is not refined so much; and besides part of the water entereth, which doth increase the spirit, and in a degree extinguish it: therefore we see that hot water will quench fire. And again we see, that in bodies wherein the water doth not much enter, but only the heat passeth, hot water worketh the effects of fire, as in eggs boiled and roasted, into which the water entereth not at all, there is scarce difference to be discerned; but in fruit and flesh, whereinto the water entereth in some part, there is much more difference.

Experiment solitary touching the qualification of heat by moisture.

684. The bottom of a vessel of boiling water, as hath been observed, is not very much heated, so as men may put their hand under the vessel and remove it. The cause is, for that the moisture of water as it quencheth coals where it entereth, so it doth allay heat where it toucheth: and therefore note well, that

moisture, although it doth not pass through bodies, without communication of some substance, as heat and cold do, yet it worketh manifest effects; not by entrance of the body, but by qualifying of the heat and cold; as we see in this instance: and we see, likewise, that the water of things distilled in water, which they call the bath, differeth not much from the water of things distilled by fire. We see also, that pewter dishes with water in them will not melt easily, but without it they will; nay we see more, that butter, or oil, which in themselves are inflammable, yet by virtue of their moisture will do the like.

Experiment solitary touching yawning.

685. It hath been noted by the ancients, that it is dangerous to pick one's ear whilst he yawneth. The cause is, for that in yawning the inner parchment of the ear is extended, by the drawing in of the spirit and breath; for in yawning, and sighing both, the spirit is first strongly drawn in, and then strongly expelled.

Experiment solitary touching the hiccough.

686. It hath been observed by the ancients, that sneezing doth cease the hiccough. The cause is, for that the motion of the hiccough is a lifting up of the stomach, which sneezing doth somewhat depress, and divert the motion another way. For first we see that the hiccough cometh of fulness of meat, especially in children, which causeth an extension of the stomach: we see also it is caused by acid meats, or drinks, which is by the pricking of the stomach; and

this motion is ceased either by diversion, or by detention of the spirits; diversion, as in sneezing; detention, as we see holding of the breath doth help somewhat to cease the hiccough; and putting a man into an earnest study doth the like, as is commonly used: and vinegar put to the nostrils, or gargarised, doth it also; for that it is astringent, and inhibiteth the motion of the spirits.

Experiment solitary touching sneezing.

687. Looking against the sun doth induce sneezing. The cause is not the heating of the nostrils, for then the holding up of the nostrils against the sun, though one wink, would do it; but the drawing down of the moisture of the brain; for it will make the eyes run with water: and the drawing of moisture to the eyes, doth draw it to the nostrils by motion of consent; and so followeth sneezing: as contrariwise, the tickling of the nostrils within, doth draw the moisture to the nostrils, and to the eyes by consent; for they also will water. But yet it hath been observed, that if one be about to sneeze, the rubbing of the eyes till they run with water will prevent it. Whereof the cause is, for that the humour which was descending to the nostrils, is diverted to the eyes.

Experiment solitary touching the tenderness of the teeth.

688. The teeth are more by cold drink, or the like, affected than the other parts. The cause is double; the one, for that the resistance of bone to cold is greater than of flesh, for that the flesh shrinketh,

but the bone resisteth, whereby the cold becometh more eager: the other is, for that the teeth are parts without blood; whereas blood helpeth to qualify the cold: and therefore we see that the sinews are much affected with cold, for that they are parts without blood; so the bones in sharp colds wax brittle: and therefore it hath been seen, that all contusions of bones in hard weather are more difficult to cure.

Experiment solitary touching the tongue.

689. It hath been noted, that the tongue receiveth more easily tokens of diseases than the other parts, as of heats within, which appear most in the blackness of the tongue. Again, pyed cattle are spotted in their tongues, &c. The cause is, no doubt, the tenderness of the part, which thereby receiveth more easily all alterations, than any other parts of the flesh.

Experiment solitary touching the taste.

690. When the mouth is out of taste, it maketh things taste sometimes salt, chiefly bitter, and sometimes lothsome, but never sweet. The cause is, the corrupting of the moisture about the tongue, which many times turneth bitter, and salt, and lothsome; but sweet never: for the rest are degrees of corruption.

Experiment solitary touching some prognostics of pestilential seasons.

691. It was observed in the great plague of the

last year, that there were seen, in divers ditches and low grounds about London, many toads that had tails two or three inches long at the least; whereas toads usually have no tails at all. Which argueth a great disposition to putrefaction in the soil and air. It is reported likewise, that roots, such as carrots and parsnips, are more sweet and luscious in infectious years than in other years.

Experiment solitary touching special simples for medicines.

692. Wise physicians should with all diligence inquire what simples nature yieldeth that have extreme subtile parts, without any mordication or acrimony: for they undermine that which is hard, they open that which is stopped and shut, and they expel that which is offensive, gently, without too much perturbation. Of this kind are elder-flowers, which therefore are proper for the stone: of this kind is the dwarf-pine, which is proper for the jaundice: of this kind is hartshorn, which is proper for agues and infections: of this kind is piony, which is proper for stoppings in the head: of this kind is fumitory, which is proper for the spleen: and a number of others. Generally, divers creatures bred of putrefaction, though they be somewhat lothsome to take, are of this kind, as earth-worms, timber-sows, snails, &c. And I conceive that the trochisks of vipers, which are so much magnified, and the flesh of snakes some ways condited and corrected, which of late are grown into some credit, are of the same nature. So

the parts of beasts putrified, as castoreum and musk, which have extreme subtile parts, are to be placed amongst them. We see also, that putrefactions of plants, as agaric and Jews-ear, are of greatest virtue. The cause is, for that putrefaction is the subtilist of all motions in the parts of bodies; and since we cannot take down the lives of living creatures, which some of the Paracelsians say, if they could be taken down, would make us immortal; the next is for subtilty of operation, to take bodies putrified, such as may be safely taken.

Experiments in consort touching Venus.

693. It hath been observed by the ancients, that much use of Venus doth dim the sight; and yet eunuchs which are unable to generate, are nevertheless also dim-sighted. The cause of dimness of sight in the former, is the expence of spirits; in the latter, the over-moisture of the brain: for the over-moisture of the brain doth thicken the spirits visual, and obstructeth their passages, as we see by the decay in the sight in age, where also the diminution of the spirits concurreth as another cause: we see also that blindness cometh by rheums and cataracts. Now in eunuchs, there are all the notes of moisture, as the swelling of their thighs, the looseness of their belly, the smoothness of their skin, &c.

694. The pleasure in the act of Venus is the greatest of the pleasures of the senses: the matching of it with itch is improper, though that also be pleasing to the touch. But the causes are profound. First,

all the organs of the senses qualify the motions of the spirits, and make so many several species of motions, and pleasures or displeasures thereupon, as there be diversities of organs. The instruments of sight, hearing, taste, and smell, are of several frame, and so are the parts for generation. Therefore Scaliger doth well to make the pleasure of generation a sixth sense; and if there were any other differing organs, and qualified perforations for the spirits to pass, there would be more than the five senses: neither do we well know whether some beasts and birds have not senses that we know not; and the very scent of dogs is almost a sense by itself. Secondly, the pleasures of the touch are greater and deeper than those of the other senses; as we see in warming upon cold; or refrigeration upon heat: for as the pains of the touch are greater than the offences of other senses; so likewise are the pleasures. It is true, that the affecting of the spirits immediately, and, as it were, without an organ, is of the greatest pleasure, which is but in two things; sweet smells and wine, and the like sweet vapours. For smells, we see their great and sudden effect in fetching men again when they swoon: for drink, it is certain that the pleasure of drunkenness is next the pleasure of Venus; and great joys, likewise, make the spirits move and touch themselves: and the pleasure of Venus is somewhat of the same kind.

695. It hath been always observed that men are more inclined to Venus in the winter, and women in

the summer. The cause is, for that the spirits, in a body more hot and dry, as the spirits of men are, by the summer are more exhaled and dissipated; and in the winter more condensed and kept entire; but in bodies that are cold and moist as women's are, the summer doth cherish the spirits, and calleth them forth; the winter doth dull them. Furthermore, the abstinence, or intermission of the use of Venus in moist and well habituate bodies, breedeth a number of diseases: and especially dangerous imposthumations. The reason is evident; for that it is a principal evacuation, especially of the spirits; for of the spirits there is scarce any evacuation, but in Venus and exercise. And therefore the omission of either of them breedeth all diseases of repletion.

Experiments in consort touching the insecta.

The nature of vivification is very worthy the inquiry: and as the nature of things is commonly better perceived in small than in great; and in imperfect than in perfect; and in parts than in whole; so the nature of vivification is best inquired in creatures bred of putrefaction. The contemplation whereof hath many excellent fruits. First, in disclosing the original of vivification. Secondly, in disclosing the original of figuration. Thirdly, in disclosing many things in the nature of perfect creatures, which in them lie more hidden. And fourthly, in traducing, by way of operation, some observations on the insecta, to work effects upon perfect creatures. Note, that

the word insecta agreeth not with the matter, but we ever use it for brevity's sake, intending by it creatures bred of putrefaction.

696. The insecta are found to breed out of several matters: some breed of mud or dung; as the earth-worms, eels, snakes, &c. For they are both putrefactions: for water in mud doth putrify, as not able to preserve itself: and for dung, all excrements are the refuse and putrefactions of nourishment. Some breed in wood, both growing and cut down. *Query*, in what woods most, and at what seasons? We see that the worms with many feet, which round themselves into balls, are bred chiefly under logs of timber, but not in the timber; and they are said to be found also many times in gardens, where no logs are. But it seemeth their generation requireth a coverture, both from sun and rain or dew, as the timber is; and therefore they are not venemous, but contrariwise are held by the physicians to clarify the blood. It is observed also, that cimices are found in the holes of bedsides. Some breed in the hair of living creatures, as lice and tikes; which are bred by the sweat close kept, and somewhat arefied by the hair. The excrements of living creatures do not only breed insecta when they are excerned, but also while they are in the body; as in worms, whereto children are most subject, and are chiefly in the guts. And it hath been lately observed by physicians, that in many pestilent diseases, there are worms found in the upper parts of the body, where excrements are not, but only humours putrified. Fleas breed principally of

straw or mats, where there hath been a little moisture; or the chamber and bed-straw kept close and not aired. It is received, that they are killed by strewing wormwood in the rooms. And it is truly observed, that bitter things are apt rather to kill, than engender putrefaction; and they be things that are fat or sweet that are aptest to putrify. There is a worm that breedeth in meal, of the shape of a large white maggot, which is given as a great dainty to nightingales. The moth breedeth upon cloth and other lanifices; especially if they be laid up dankish and wet. It delighteth to be about the flame of a candle. There is a worm called a wevil, bred under ground, and that feedeth upon roots; as parsnips, carrots, &c. Some breed in waters, especially shaded, but they must be standing waters; as the water-spider that hath six legs. The fly called the gad-fly, breedeth of somewhat that swimmeth upon the top of the water, and is most about ponds. There is a worm that breedeth of the dregs of wine decayed; which afterwards, as is observed by some of the ancients, turneth into a gnat. It hath been observed by the ancients, that there is a worm that breedeth in old snow, and is of colour reddish, and dull of motion, and dieth soon after it cometh out of snow. Which should shew, that snow hath in it a secret warmth; for else it could hardly vivify. And the reason of the dying of the worm, may be the sudden exhaling of that little spirit, as soon as it cometh out of the cold, which had shut it in. For as butterflies quicken with heat, which were benumbed with cold;

so spirits may exhale with heat, which were preserved in cold. It is affirmed both by the ancient and modern observation, that in furnaces of copper and brass where chalcites, which is vitriol, is often cast in to mend the working, there riseth suddenly a fly, which sometimes moveth as if it took hold on the walls of the furnace: sometimes is seen moving in the fire below; and dieth presently as soon as it is out of the furnace: which is a noble instance, and worthy to be weighed; for it sheweth, that as well violent heat of fire, as the gentle heat of living creatures, will vivify, if it have matter proportionable. Now the great axiom of vivification is, that there must be heat to dilate the spirit of the body; an active spirit to be dilated; matter viscous or tenacious to hold in the spirit; and that matter to be put forth and figured. Now a spirit dilated by so ardent a fire as that of the furnace, as soon as ever it cooleth never so little, congealeth presently. And, no doubt, this action is furthered by the chalcites, which hath a spirit that will put forth and germinate, as we see in chymical trials. Briefly, most things putrified bring forth insecta of several names; but we will not take upon us now to enumerate them all.

697. The insecta have been noted by the ancients to feed little: but this hath not been diligently observed; for grasshoppers eat up the green of whole countries; and silk-worms devour leaves swiftly; and ants make great provision. It is true, that creatures that sleep and rest much, eat little; as dormice and bats, &c. They are all without blood: which may

be, for that the juice of their bodies is almost all one; not blood, and flesh, and skin, and bone, as in perfect creatures; the integral parts have extreme variety, but the similar parts little. It is true, that they have, some of them, a diaphragm and an intestine; and they have all skins; which in most of the insecta are cast often. They are not generally, of long life; yet bees have been known to live seven years: and snakes are thought, the rather for the casting of their spoil, to live till they be old: and eels, which many times breed of putrefaction, will live and grow very long: and those that interchange from worms to flies in the summer, and from flies to worms in the winter, have been kept in boxes four years at the least. Yet there are certain flies that are called ephemera that live but a day. The cause is the exility of the spirit, or perhaps the absence of the sun; for that if they were brought in, or kept close, they might live longer. Many of the insecta, as butterflies and other flies, revive easily when they seem dead, being brought to the sun or fire. The cause whereof is the diffusion of the vital spirit, and the easy dilating of it by a little heat. They stir a good while after their heads are off, or that they be cut in pieces; which is caused also, for that their vital spirits are more diffused throughout all their parts, and less confined to organs than in perfect creatures.

698. The insecta have voluntary motion, and therefore imagination; and whereas some of the ancients have said, that their motion is indeterminate, and their imagination indefinite, it is negligently ob-

served; for ants go right forward to their hills, and bees do admirably know the way from a flowery heath two or three miles off to their hives. It may be, gnats and flies have their imagination more mutable and giddy, as small birds likewise have. It is said by some of the ancients, that they have only the sense of feeling, which is manifestly untrue; for if they go forth right to a place, they must needs have sight; besides they delight more in one flower or herb than in another, and therefore have taste: and bees are called with sound upon brass, and therefore they have hearing; which sheweth likewise, that though their spirit be diffused, yet there is a seat of their senses in their head.

Other observations concerning the insecta, together with the enumeration of them, we refer to that place, where we mean to handle the title of animals in general.

Experiment solitary touching leaping.

699. A man leapeth better with weights in his hands than without. The cause is, for that the weight, if it be proportionable, strengtheneth the sinews by contracting them. For otherwise, where no contraction is needful, weight hindereth. As we see in horse-races, men are curious to foresee, that there be not the least weight upon the one horse more than upon the other. In leaping with weights the arms are first cast backwards, and then forwards, with so much the greater force; for the hands go backward before they take their rise.

Query, if the contrary motion of the spirits, immediately before the motion we intend, doth not cause the spirits as it were to break forth with more force? as breath also, drawn and kept in, cometh forth more forcibly: and in casting of any thing, the arms, to make a greater swing, are first cast backward.

Experiment solitary touching the pleasures and displeasures of the senses, especially of hearing.

700. Of musical tones and unequal sounds we have spoken before; but touching the pleasure and displeasure of the senses, not so fully. Harsh sounds, as of a saw when it is sharpened; grinding of one stone against another; squeaking or skreeching noise; make a shivering or horror in the body, and set the teeth on edge. The cause is, for that the objects of the ear do affect the spirits, immediately, most with pleasure and offence. We see there is no colour that affecteth the eye much with displeasure: there be sights that are horrible, because they excite the memory of things that are odious or fearful; but the same things painted do little affect. As for smells, tastes, and touches, they be things that do affect by a participation or impulsion of the body of the object. So it is sound alone that doth immediately and incorporeally affect most; this is most manifest in music, and concords and discords in music; for all sounds, whether they be sharp or flat, if they be sweet, have a roundness and equality; and if they be harsh, are unequal; for a discord itself is but a harshness of divers sounds meeting. It is true that inequality

not stayed upon, but passing, is rather an increase of sweetness; as in the purling of a wreathed string; and in the raucity of a trumpet; and in the nightingale-pipe of a regal; and in a discord straight falling upon a concord; but if you stay upon it, it is offensive: and therefore there be these three degrees of pleasing and displeasing in sounds, sweet sounds, discords, and harsh sounds, which we call by divers names, as skreeching or grating, such as we now speak of. As for the setting of the teeth on edge, we see plainly what an intercourse there is between the teeth and the organ of the hearing, by the taking of the end of a bow between the teeth, and striking upon the string.

NATURAL HISTORY.

CENTURY VIII.

Experiment solitary touching veins of medicinal earth.

701. There be minerals and fossils in great variety; but of veins of earth medicinal, but few; the chief are, terra lemnia, terra sigillata communis, and bolus armenus; whereof terra lemnia is the chief. The virtues of them are, for curing of wounds, stanching of blood, stopping of fluxes, and rheums, and arresting the spreading of poison, infection, and putrefaction: and they have of all other simples the perfectest and purest quality of drying, with little or no mixture of any other quality. Yet it is true, that the bole-armoniac is the most cold of them, and that terra lemnia is the most hot, for which cause the island Lemnos, where it is digged, was in the old fabulous ages consecrated to Vulcan.

Experiment solitary touching the growth of sponges.

702. About the bottom of the Straits are gathered great quantities of sponges, which are gathered from the sides of rocks, being as it were a large but tough moss. It is the more to be noted, because that there be but few substances, plant-like, that grow deep within the sea; for they are gathered sometimes

fifteen fathom deep: and when they are laid on shore, they seem to be of great bulk; but crushed together, will be transported in a very small room.

Experiment solitary touching sea-fish put in fresh waters.

703. It seemeth that fish that are used to the salt water, do nevertheless delight more in fresh. We see, that salmons and smelts love to get into rivers, though it be against the stream. At the haven of Constantinople you shall have great quantities of fish that come from the Euxine sea, that when they come into the fresh water, do inebriate, and turn up their bellies, so as you may take them with your hand. I doubt there hath not been sufficient experiment made of putting sea-fish into fresh water ponds, and pools. It is a thing of great use and pleasure; for so you may have them new at some good distance from the sea: and besides, it may be, the fish will eat the pleasanter, and may fall to breed. And it is said, that Colchester oysters, which are put into pits, where the sea goeth and cometh, but yet so that there is a fresh water coming also to them when the sea voideth, become by that means fatter, and more grown.

Experiment solitary touching attraction by similitude of substance.

704. The Turkish bow giveth a very forcible shoot; insomuch as it hath been known, that the arrow hath pierced a steel target, or a piece of brass of two inches thick: but that which is more strange, the ar-

row, if it be headed with wood, hath been known to pierce through a piece of wood of eight inches thick. And it is certain, that we had in use at one time, for sea fight, short arrows, which they called sprights, without any other heads, save wood sharpened: which were discharged out of muskets, and would pierce through the sides of ships where a bullet would not pierce. But this dependeth upon one of the greatest secrets in all nature; which is, that similitude of substance will cause attraction, where the body is wholly freed from the motion of gravity: for if that were taken away, lead would draw lead, and gold would draw gold, and iron would draw iron, without the help of the loadstone. But this same motion of weight or gravity, which is a mere motion of the matter, and hath no affinity with the form or kind, doth kill the other motion, except itself be killed by a violent motion, as in these instances of arrows; for then the motion of attraction by similitude of substance beginneth to shew itself. But we shall handle this point of nature fully in due place.

Experiment solitary touching certain drinks in Turkey.

705. They have in Turkey and the east certain confections, which they call servets, which are like to candied conserves, and are made of sugar and lemons, or sugar and citrons, or sugar and violets, and some other flowers; and some mixture of amber for the more delicate persons: and those they dissolve in water, and thereof make their drink,

because they are forbidden wine by their law. But I do much marvel, that no Englishman, or Dutchman, or German, doth set up brewing in Constantinople; considering they have such quantity of barley. For as for the general sort of men, frugality may be the cause of drinking water; for that it is no small saving to pay nothing for one's drink: but the better sort might well be at the cost. And yet I wonder the less at it, because I see France, Italy, or Spain, have not taken into use beer or ale; which, perhaps, if they did, would better both their healths and their complexions. It is likely it would be matter of great gain to any that should begin it in Turkey.

Experiments in consort touching sweat.

706. In bathing in hot water, sweat, nevertheless, cometh not in the parts under the water. The cause is; first, for that sweat is a kind of colliquation, and that kind of colliquation is not made either by an over-dry heat, or an over-moist heat: for over-moisture doth somewhat extinguish the heat, as we see that even hot water quencheth fire; and over-dry heat shutteth the pores: and therefore men will sooner sweat covered before the sun or fire, than if they stood naked: and earthen bottles, filled with hot water, do provoke in bed a sweat more daintily than brick-bats hot. Secondly, hot water doth cause evaporation from the skin; so as it spendeth the matter in those parts under the water, before it issueth in sweat,

Again, sweat cometh more plentifully, if the heat be increased by degrees, than if it be greatest at first, or equal. The cause is, for that the pores are better opened by a gentle heat, than by a more violent; and by their opening, the sweat issueth more abundantly. And therefore physicians may do well when they provoke sweat in bed by bottles, with a decoction of sudorific herbs in hot water, to make two degrees of heat in the bottles; and to lay in the bed the less heated first, and after half an hour, the more heated.

707. Sweat is salt in taste; the cause is, for that that part of the nourishment which is fresh and sweet, turneth into blood and flesh; and the sweat is only that part which is separate and excerned. Blood also raw hath some saltness more than flesh: because the assimilation into flesh is not without a little and subtile excretion from the blood.

708. Sweat cometh forth more out of the upper parts of the body than the lower; the reason is, because those parts are more replenished with spirits; and the spirits are they that put forth sweat: besides, they are less fleshy, and sweat issueth, chiefly, out of the parts that are less fleshy, and more dry; as the forehead and breast.

709. Men sweat more in sleep than waking; and yet sleep doth rather stay other fluxions, than cause them; as rheums, looseness of the body, &c. The cause is, for that in sleep the heat and spirits do naturally move inwards, and there rest. But when

they are collected once within, the heat becometh more violent and irritate; and thereby expelleth sweat.

710. Cold sweats are, many times, mortal, and near death: and always ill, and suspected: as in great fears, hypochondriacal passions, &c. The cause is, for that cold sweats come by a relaxation or forsaking of the spirits, whereby the moisture of the body, which heat did keep firm in the parts, severeth and issueth out.

711. In those diseases which cannot be discharged by sweat, sweat is ill, and rather to be stayed; as in diseases of the lungs, and fluxes of the belly: but in those diseases which are expelled by sweat, it easeth and lighteneth; as in agues, pestilences, &c. The cause is, for that sweat in the latter sort is partly critical, and sendeth forth the matter that offendeth; but in the former, it either proceedeth from the labour of the spirits, which sheweth them oppressed; or from motion of consent, when nature, not able to expel the disease where it is seated, moveth to an expulsion indifferent over all the body.

Experiment solitary touching the glow-worm.

712. The nature of the glow-worm is hitherto not well observed. Thus much we see; that they breed chiefly in the hottest months of summer; and that they breed not in champain, but in bushes and hedges. Whereby it may be conceived, that the spirit of them is very fine, and not to be refined but by summer heats: and again, that by reason of the

fineness, it doth easily exhale. In Italy, and the hotter countries, there is a fly they call lucciole, that shineth as the glow-worm doth; and it may be is the flying glow-worm. But that fly is chiefly upon fens and marshes. But yet the two former observations hold; for they are not seen but in the heat of summer; and sedge, or other green of the fens, give as good shade as bushes. It may be the glow-worms of the cold countries ripen not so far as to be winged.

Experiments in consort touching the impressions which the passions of the mind make upon the body.

713. The passions of the mind work upon the body the impressions following. Fear causeth paleness, trembling, the standing of the hair upright, starting, and shrieking. The paleness is caused, for that the blood runneth inward to succour the heart. The trembling is caused, for that through the flight of the spirits inward, the outward parts are destituted, and not sustained. Standing upright of the hair is caused, for that by the shutting of the pores of the skin, the hair that lieth aslope must needs rise. Starting is both an apprehension of the thing feared, and in that kind it is a motion of shrinking, and likewise an inquisition in the beginning, what the matter should be, and in that kind it is a motion of erection, and therefore when a man would listen suddenly to any thing, he starteth; for the starting is an erection of the spirits to attend. Skreeching is an appetite of expelling that which suddenly striketh

the spirits: for it must be noted, that many motions, though they be unprofitable to expel that which hurteth, yet they are offers of nature, and cause motions by consent, as in groaning, or crying upon pain.

714. Grief and pain cause sighing, sobbing, groaning, screaming, and roaring; tears, distorting of the face, grinding of the teeth, sweating. Sighing is caused by the drawing in of a greater quantity of breath to refresh the heart that laboureth; like a great draught when one is thirsty. Sobbing is the same thing stronger. Groaning, and screaming, and roaring, are caused by an appetite of expulsion, as hath been said: for when the spirits cannot expel the thing that hurteth, in their strife to do it, by motion of consent, they expel the voice. And this is when the spirits yield, and give over to resist: for if one do constantly resist pain, he will not groan. Tears are caused by a contraction of the spirits of the brain: which contraction by consequence astringeth the moisture of the brain, and thereby sendeth tears into the eyes. And this contraction or compression causeth also wringing of the hands; for wringing is a gesture of expression of moisture. The distorting of the face is caused by a contention, first to bear and resist, and then to expel; which maketh the parts knit first, and afterwards open. Grinding of the teeth is caused likewise, by a gathering and serring of the spirits together to resist, which maketh the teeth also to sit hard one against another. Sweating is also a compound motion, by the labour of the spirits, first to resist, and then to expel.

715. Joy causeth a cheerfulness and vigour in the eyes, singing, leaping, dancing, and sometimes tears. All these are the effects of the dilatation and coming forth of the spirits into the outward parts; which maketh them more lively and stirring. We know it hath been seen, that excessive sudden joy hath caused present death, while the spirits did spread so much as they could not retire again. As for tears, they are the effects of compression of the moisture of the brain, upon dilatation of the spirits. For compression of the spirits worketh an expression of the moisture of the brain by consent, as hath been said in grief. But then in joy, it worketh it diversly, viz. by propulsion of the moisture, when the spirits dilate, and occupy more room.

716. Anger causeth paleness in some, and the going and coming of the colour in others: also trembling in some: swelling, foaming at the mouth, stamping, bending of the fist. Paleness, and going and coming of the colour, are caused by the burning of the spirits about the heart; which to refresh themselves, call in more spirits from the outward parts. And if the paleness be alone, without sending forth the colour again, it is commonly joined with some fear; but in many there is no paleness at all, but contrariwise redness about the cheeks and gills; which is by the sending forth of the spirits in an appetite to revenge. Trembling in anger is likewise by a calling in of the spirits; and is commonly when anger is joined with fear. Swelling is caused, both by a dilatation of the spirits by over-heating, and by

a liquefaction or boiling of the humours thereupon. Foaming at the mouth is from the same cause, being an ebullition. Stamping, and bending of the fist, are caused by an imagination of the act of revenge.

717. Light displeasure or dislike causeth shaking of the head, frowning and knitting of the brows. These effects arise from the same causes that trembling and horror do; namely, from the retiring of the spirits, but in a less degree. For the shaking of the head is but a slow and definite trembling; and is a gesture of slight refusal; and we see also, that a dislike causeth, often, that gesture of the hand, which we use when we refuse a thing, or warn it away. The frowning and knitting of the brows is a gathering, or serring of the spirits, to resist in some measure. And we see also this knitting of the brows will follow upon earnest studying, or cogitation of any thing, though it be without dislike.

718. Shame causeth blushing, and casting down of the eyes. Blushing is the resort of blood to the face; which in the passion of shame is the part that laboureth most. And although the blushing will be seen in the whole breast if it be naked, yet that is but in passage to the face. As for the casting down of the eyes, it proceedeth of the reverence a man beareth to other men; whereby, when he is ashamed, he cannot endure to look firmly upon others: and we see, that blushing, and the casting down of the eyes both, are more when we come before many; "ore Pompeii quid mollius? nunquam non coram pluribus

erubuit:" and likewise when we come before great or reverend persons.

719. Pity causeth sometimes tears; and a flexion or cast of the eye aside. Tears come from the same cause that they do in grief: for pity is but grief in another's behalf. The cast of the eye is a gesture of aversion, or lothness to behold the object of pity.

720. Wonder causeth astonishment, or an immoveable posture of the body; casting up of the eyes to heaven, and lifting up of the hands. For astonishment, it is caused by the fixing of the mind upon one object of cogitation, whereby it doth not spatiate and transcur, as it useth; for in wonder the spirits fly not, as in fear; but only settle, and are made less apt to move. As for the casting up of the eyes, and lifting up of the hands, it is a kind of appeal to the Deity, which is the author, by power and providence, of strange wonders.

721. Laughing causeth a dilatation of the mouth and lips; a continual expulsion of the breath, with the loud noise, which maketh the interjection of laughing; shaking of the breast and sides; running of the eyes with water, if it be violent and continued. Wherein first it is to be understood, that laughing is scarce, properly, a passion, but hath its source from the intellect; for in laughing there ever precedeth a conceit of somewhat ridiculous, and therefore it is proper to man. Secondly, that the cause of laughing is but a light touch of the spirits. And not so deep an impression as in other passions. And therefore, that which hath not affinity with the passions of

the mind, it is moved, and that in great vehemency, only by tickling some parts of the body: and we see that men even in a grieved state of mind, yet cannot sometimes forbear laughing. Thirdly, it is ever joined with some degree of delight: and therefore exhilaration hath some affinity with joy, thought it be a much lighter motion: "res severa est verum gaudium." Fourthly, that the object of it is deformity; absurdity, shrewd turns, and the like. Now to speak of the causes of the effects before mentioned, whereunto these general notes give some light. For the dilatation of the mouth and lips, continued expulsion of the breath and voice, and shaking of the breast and sides, they proceed, all, from the dilatation of the spirits; especially being sudden. So likewise, the running of the eyes with water, as hath been formerly touched, where we spake of the tears of joy and grief, is an effect of dilatation of the spirits. And for suddenness, it is a great part of the matter: for we see, that any shrewd turn that lighteth upon another; or any deformity, &c. moveth laughter in the instant, which after a little time it doth not. So we cannot laugh at any thing after it is stale, but whilst it is new: and even in tickling, if you tickle the sides, and give warning, or give a hard or continued touch, it doth not move laughter so much.

722. Lust causeth a flagrancy in the eyes, and priapism. The cause of both these is, for that in lust, the sight and the touch are the things desired, and therefore the spirits resort to those parts which are most affected. And note well in general, for that great

use may be made of the observation, that, evermore, the spirits, in all passions, resort most to the parts that labour most, or are most affected. As in the last which hath been mentioned, they resort to the eyes and venereous parts: in fear and anger to the heart: in shame to the face: and in light dislikes to the head.

Experiments in consort touching drunkenness.

723. It hath been observed by the ancients, and is yet believed, that the sperm of drunken men is unfruitful. The cause is, for that it is over-moistened, and wanteth spissitude: and we have a merry saying, that they that go drunk to bed get daughters.

724. Drunken men are taken with a plain defect, or destitution in voluntary motion. They reel; they tremble; they cannot stand, nor speak strongly. The cause is, for that the spirits of the wine oppress the spirits animal, and occupy part of the place where they are, and so make them weak to move. And therefore drunken men are apt to fall asleep: and opiates, and stupefactives, as poppy, hen-bane, hemlock, &c. induce a kind of drunkenness, by the grossness of their vapour, as wine doth by the quantity of the vapour. Besides, they rob the spirits animal of their matter, whereby they are nourished: for the spirits of the wine prey upon it as well as they: and so they make the spirits less supple and apt to move.

725. Drunken men imagine every thing turneth round: they imagine also that things come upon them:

they see not well things afar off; those things that they see near hand, they see out of their place; and sometimes they see things double. The cause of the imagination that things turn round is, for that the spirits themselves turn, being compressed by the vapour of the wine, for any liquid body upon compression turneth, as we see in water, and it is all one to the sight, whether the visual spirits move, or the object moveth, or the medium moveth. And we see that long turning round breedeth the same imagination. The cause of the imagination that things come upon them is, for that the spirits visual themselves draw back; which maketh the object seem to come on; and besides, when they see things turn round and move, fear maketh them think they come upon them. The cause that they cannot see things afar off, is the weakness of the spirits; for in every megrim or vertigo there is an obtenebration joined with a semblance of turning round; which we see also in the lighter sort of swoonings. The cause of seeing things out of their place, is the refraction of the spirits visual; for the vapour is as an unequal medium; and it is as the sight of things out of place in water. The cause of seeing things double, is the swift and unquiet motion of the spirits, being oppressed, to and fro; for, as was said before, the motion of the spirits visual, and the motion of the object, make the same appearances; and for the swift motion of the object, we see that if you fillip a lute-string, it sheweth double or treble.

726. Men are sooner drunk with small draughts than with great. And again, wine sugared inebri-

ateth less than wine pure. The cause of the former is, for that the wine descendeth not so fast to the bottom of the stomach, but maketh longer stay in the upper part of the stomach, and sendeth vapours faster to the head; and therefore inebriateth sooner. And for the same reason, sops in wine, quantity for quantity, inebriate more than wine of itself. The cause of the latter is, for that the sugar doth inspissate the spirits of the wine, and maketh them not so easy to resolve into vapour. Nay farther, it is thought to be some remedy against inebriating, if wine sugared be taken after wine pure. And the same effect is wrought either by oil or milk, taken upon much drinking.

Experiment solitary touching the help or hurt of wine, though moderately used.

727. The use of wine in dry and consumed bodies is hurtful; in moist and full bodies it is good. The cause is, for that the spirits of the wine do prey upon the dew or radical moisture, as they term it, of the body, and so deceive the animal spirits. But where there is moisture enough, or superfluous, there wine helpeth to digest, and desiccate the moisture.

Experiment solitary touching caterpillars.

728. The caterpillar is one of the most general of worms, and breedeth of dew and leaves; for we see infinite number of caterpillars which breed upon trees and hedges, by which the leaves of the trees or hedges are in great part consumed; as well by their breed-

ing out of the leaf, as by their feeding upon the leaf. They breed in the spring chiefly, because then there is both dew and leaf. And they breed commonly when the east winds have much blown; the cause whereof is, the dryness of that wind; for to all vivification upon putrefaction, it is requisite the matter be not too moist: and therefore we see they have cobwebs about them, which is a sign of a slimy dryness; as we see upon the ground, whereupon, by dew and sun, cobwebs breed all over. We see also the green caterpillar breedeth in the inward parts of roses, especially not blown, where the dew sticketh; but especially caterpillars, both the greatest, and the most, breed upon cabbages, which have a fat leaf, and apt to putrify. The caterpillar, towards the end of summer, waxeth volatile, and turneth to a butterfly, or perhaps some other fly. There is a caterpillar that hath a fur or down upon it, and seemeth to have affinity with the silk-worm.

Experiment solitary touching the flies cantharides.

729. The flies cantharides are bred of a worm or caterpillar, but peculiar to certain fruit-trees; as are the fig-tree, the pine-tree, and the wild brier; all which bear sweet fruit, and fruit that hath a kind of secret biting or sharpness: for the fig hath a milk in it that is sweet and corrosive; the pine-apple hath a kernel that is strong and abstersive: the fruit of the brier is said to make children, or those that eat them, scabbed. And therefore no marvel, though cantharides have such a corrosive and cauterising

quality; for there is not any other of the insecta, but is bred of a duller matter. The body of the cantharides is bright coloured; and it may be, that the delicate coloured dragon-flies may have likewise some corrosive quality.

Experiments in consort touching lassitude.

730. Lassitude is remedied by bathing, or anointing with oil and warm water. The cause is, for that all lassitude is a kind of contusion, and compression of the parts; and bathing and anointing give a relaxation or emollition; and the mixture of oil and water is better than either of them alone; because water entereth better into the pores, and oil after entry softeneth better. It is found also, that the taking of tobacco doth help and discharge lassitude. The reason whereof is, partly, because by cheering or comforting of the spirits, it openeth the parts compressed or contused; and chiefly because it refresheth the spirits by the opiate virtue thereof, and so dischargeth weariness, as sleep likewise doth.

731. In going up a hill, the knees will be most weary; in going down a hill, the thighs. The cause is, for that in the lift of the feet, when a man goeth up the hill, the weight of the body beareth most upon the knees; and in going down the hill, upon the thighs.

Experiment solitary touching the casting of the skin and shell in some creatures.

732. The casting of the skin is by the ancients

compared to the breaking of the secundine, or caul, but not rightly: for that were to make every casting of the skin a new birth: and besides, the secundine is but a general cover, not shaped according to the parts, but the skin is shaped according to the parts. The creatures that cast their skin are, the snake, the viper, the grasshopper, the lizard, the silk-worm, &c. Those that cast their shell are, the lobster, the crab, the crawfish, the hodmandod or dedman, the tortoise, &c. The old skins are found, but the old shells never: so as it is like, they scale off, and crumble away by degrees. And they are known by the extreme tenderness and softness of the new shell, and somewhat by the freshness of the colour of it. The cause of the casting of skin and shell should seem to be the great quantity of matter in those creatures that is fit to make skin or shell; and again, the looseness of the skin or shell, that sticketh not close to the flesh. For it is certain, that it is the new skin or shell that putteth off the old: so we see, that in deer it is the young horn that putteth off the old; and in birds, the young feathers put off the old: and so birds that have much matter for their beak, cast their beaks, the new beak putting off the old.

Experiments in consort touching the postures of the body.

733. Lying not erect, but hollow, which is in the making of the bed: or with the legs gathered up, which is in the posture of the body, is the more wholesome. The reason is, the better comforting of

the stomach, which is by that less pensile: and we see that in weak stomachs, the laying up of the legs high, and the knees almost to the mouth, helpeth and comforteth. We see also, that galley-slaves, notwithstanding their misery otherwise, are commonly fat and fleshy; and the reason is, because the stomach is supported somewhat in sitting, and is pensile in standing or going. And therefore, for prolongation of life, it is good to choose these exercises where the limbs move more than the stomach and belly; as in rowing, and in sawing, being set.

734. Megrims and giddiness are rather when we rise after long sitting, than while we sit. The cause is, for that the vapours, which were gathered by sitting, by the sudden motion fly more up into the head.

735. Leaning long upon any part maketh it numb, and as we call it asleep. The cause is, for that the compression of the part suffereth not the spirits to have free access; and therefore when we come out of it, we feel a stinging or pricking, which is the reentrance of the spirits.

Experiments solitary touching pestilential years.

736. It hath been noted, that those years are pestilential and unwholesome, when there are great numbers of frogs, flies, locusts, &c. The cause is plain; for that those creatures being engendered of putrefaction, when they abound, shew a general disposition of the year, and constitution of the air, to diseases of putrefaction. And the same prognostic, as hath been said before, holdeth, if you find worms

in oak-apples: for the constitution of the air appeareth more subtilly in any of these things, than to the sense of man.

Experiment solitary touching the prognostics of hard winters.

737. It is an observation amongst country people, that years of store of haws and hips do commonly portend cold winters; and they ascribe it to God's providence, that, as the Scripture saith, reacheth even to the falling of a sparrow; and much more is like to reach to the preservation of birds in such seasons. The natural cause also may be the want of heat, and abundance of moisture, in the summer precedent; which putteth forth those fruits, and must needs leave great quantity of cold vapours not dissipated; which causeth the cold of the winter following.

Experiment solitary, touching medicines that condense and relieve the spirits.

738. They have in Turkey a drink called coffee, made of a berry of the same name, as black as soot, and of a strong scent, but not aromatical; which they take, beaten into powder, in water, as hot as they can drink it: and they take it, and sit at it in their coffee-houses, which are like our taverns. This drink comforteth the brain and heart, and helpeth digestion. Certainly this berry coffee, the root and leaf beetle, the leaf tobacco, and the tear of poppy, opium, of which the Turks are great takers, supposing it expelleth all fear, do all condense the spirits, and make

them strong and aleger. But it seemeth they are taken after several manners; for coffee and opium are taken down, tobacco but in smoke, and beetle is but champed in the mouth with a little lime. It is like there are more of them, if they were well found out, and well corrected. Query, of henbane-seed; of mandrake; of saffron, root and flower; of folium indum; of ambergrease; of the Assyrian amomum, if it may be had; and of the scarlet powder which they call kermes: and, generally, of all such things as do inebriate and provoke sleep. Note, that tobacco is not taken in root or seed, which are more forcible ever than leaves.

Experiment solitary touching paintings of the body.

739. The Turks have a black powder, made of a mineral called alcohol, which with a fine long pencil they lay under their eye-lids, which doth colour them black; whereby the white of the eye is set off more white. With the same powder they colour also the hairs of their eye-lids, and of their eye-brows, which they draw into embowed arches. You shall find that Xenophon maketh mention, that the Medes used to paint their eyes. The Turks use with the same tincture to colour the hair of their heads and beards black. And divers with us that are grown grey, and yet would appear young, find means to make their hair black, by combing it, as they say, with a leaden comb, or the like. As for the Chineses, who are of an ill complexion, being olivaster, they paint their cheeks scarlet, especially their king and grandees.

Generally, barbarous people, that go naked, do not only paint themselves, but they pounce and raise their skin, that the painting may not be taken forth; and make it into works. So do the West Indians; and so did the ancient Picts and Britons; so that it seemeth men would have the colours of birds' feathers, if they could tell how; or at least they will have gay skins instead of gay clothes.

Experiment solitary touching the use of bathing and anointing.

740. It is strange that the use of bathing, as a part of diet, is left. With the Romans and Grecians it was as usual as eating or sleeping; and so is it amongst the Turks at this day: whereas with us it remaineth but as a part of physic. I am of opinion, that the use of it, as it was with the Romans, was hurtful to health; for that it made the body soft, and easy to waste. For the Turks it is more proper, because that their drinking water and feeding upon rice, and other food of small nourishment, maketh their bodies so solid and hard, as you need not fear that bathing should make them frothy. Besides, the Turks are great sitters, and seldom walk, whereby they sweat less, and need bathing more. But yet certain it is that bathing, and especially anointing, may be so used as it may be a great help to health, and prolongation of life. But hereof we shall speak in due place, when we come to handle experiments medicinal.

Experiment solitary touching chambletting of paper.

741. The Turks have a pretty art of chambletting of paper, which is not with us in use. They take divers oiled colours, and put them severally, in drops, upon water, and stir the water lightly, and then wet their paper, being of some thickness, with it, and the paper will be waved and veined, like chamblet or marble.

Experiment solitary touching cuttle-ink.

742. It is somewhat strange, that the blood of all birds and beasts and fishes should be of a red colour, and only the blood of the cuttle should be as black as ink. A man would think, that the cause should be the high concoction of that blood; for we see in ordinary puddings, that the boiling turneth the blood to be black; and the cuttle is accounted a delicate meat, and is much in request.

Experiment solitary touching increase of weight in earth.

743. It is reported of credit, that if you take earth from land adjoining to the river of Nile, and preserve it in that manner that it neither come to be wet nor wasted; and weigh it daily, it will not alter weight until the seventeenth of June, which is the day when the river beginneth to rise; and then it will grow more and more ponderous, till the river cometh to its height. Which if it be true, it cannot

be caused but by the air, which then beginneth to condense; and so turneth within that small mold into a degree of moisture, which produceth weight. So it hath been observed, that tobacco cut, and weighed, and then dried by the fire, loseth weight; and after being laid in the open air, recovereth weight again. And it should seem, that as soon as ever the river beginneth to increase, the whole body of the air thereabouts suffereth a change: for, that which is more strange, it is credibly affirmed, that upon that very day when the river first riseth, great plagues in Cairo use suddenly to break up.

Experiments in consort touching sleep.

744. Those that are very cold, and especially in their feet, cannot get to sleep: the cause may be, for that in sleep is required a free respiration, which cold doth shut in and hinder; for we see that in great colds, one can scarce draw his breath. Another cause may be, for that cold calleth the spirits to succour, and therefore they cannot so well close, and go together in the head, which is ever requisite to sleep. And for the same cause, pain and noise hinder sleep; and darkness, contrariwise, furthereth sleep.

745. Some noises, whereof we spake in the hundred and twelfth experiment, help sleep: as the blowing of the wind, the trickling of water, humming of bees, soft singing, reading, &c. The cause is, for that they move in the spirits a gentle attention; and whatsoever moveth attention without too much labour stilleth the natural and discursive motion of the spirits.

746. Sleep nourisheth, or at least preserveth bodies, a long time, without other nourishment. Beasts that sleep in winter, as it is noted of wild bears, during their sleep wax very fat, though they eat nothing. Bats have been found in ovens, and other hollow close places, matted one upon another: and therefore it is likely that they sleep in the winter time, and eat nothing. *Query*, whether bees do not sleep all winter, and spare their honey? Butterflies, and other flies, do not only sleep, but lie as dead all winter; and yet with a little heat of sun or fire, revive again. A dormouse, both winter and summer, will sleep some days together, and eat nothing.

Experiments in consort touching teeth and hard substances in the bodies of living creatures.

To restore teeth in age, were magnale naturæ. It may be thought of. But howsoever, the nature of the teeth deserveth to be inquired of, as well as the other parts of living creatures' bodies.

747. There be five parts in the bodies of living creatures, that are of hard substance; the skull, the teeth, the bones, the horns, and the nails. The greatest quantity of hard substance continued is towards the head. For there is the skull of one intire bone; there are the teeth,; there are the maxillary bones; there is the hard bone that is the instrument of hearing; and thence issue the horns; so that the building of living creatures' bodies is like the building of a timber house, where the walls and other parts have columns and beams; but the roof is, in the bet-

ter sort of houses, all tile, or lead, or stone. As for birds, they have three other hard substances proper to them; the bill, which is of like matter with the teeth: for no birds have teeth: the shell of the egg: and their quills: for as for their spur, it is but a nail. But no living creatures that have shells very hard, as oysters, cockles, muscles, scallops, crabs, lobsters, craw-fish, shrimps, and especially the tortoise, have bones within them, but only little gristles.

748. Bones, after full growth, continue at a stay; and so doth the skull: horns, in some creatures, are cast and renewed: teeth stand at a stay, except their wearing: as for nails, they grow continually: and bills and beaks will overgrow, and sometimes be cast, as in eagles and parrots.

749. Most of the hard substances fly to the extremes of the body: as skull, horns, teeth, nails, and beaks: only the bones are more inward, and clad with flesh. As for the entrails, they are all without bones; save that a bone is sometimes found in the heart of a stag; and it may be in some other creature.

750. The skull hath brains, as a kind of marrow, within it. The back-bone hath one kind of marrow, which hath an affinity with the brain; and other bones of the body have another. The jaw-bones have no marrow severed, but a little pulp of marrow diffused. Teeth likewise are thought to have a kind of marrow diffused, which causeth the sense and pain; but it is rather sinew: for marrow hath no sense, no more than blood. Horn is alike throughout; and so is the nail.

751. None other of the hard substances have sense, but the teeth; and the teeth have sense, not only of pain, but of cold.

But we will leave the inquiries of other hard substances unto their several places, and now inquire only of the teeth.

752. The teeth are, in men, of three kinds: sharp, as the fore-teeth: broad, as the back-teeth, which we call the molar-teeth, or grinders, and pointed teeth, or canine, which are between both. But there have been some men that have had their teeth undivided, as of one whole bone, with some little mark in the place of the division, as Pyrrhus had. Some creatures have over-long or out-growing teeth, which we call fangs, or tusks: as boars, pikes, salmons, and dogs, though less. Some living creatures have teeth against teeth, as men and horses; and some have teeth, especially their master-teeth, indented one within another like saws, as lions; and so again have dogs. Some fishes have divers rows of teeth in the roofs of their mouths, as pikes, salmons, trouts, &c. And many more in salt-waters. Snakes and other serpents have venomous teeth, which are sometimes mistaken for their sting.

753. No beast that hath horns hath upper teeth; and no beast that hath teeth above wanteth them below: but yet if they be of the same kind, it followeth not, that if the hard matter goeth not into upper teeth, it will go into horns, nor yet e converso; for does, that have no horns, have no upper teeth.

754. Horses have, at three years old, a tooth put

forth, which they call the colt's tooth: and at four years old there cometh the mark tooth, which hath a hole as big as you may lay a pea within it, and that weareth shorter and shorter every year, till that at eight years old the tooth is smooth, and the hole gone: and then they say, that the mark is out of the horse's mouth.

755. The teeth of men breed first, when the child is about a year and half old: and then they cast them, and new come about seven years old. But divers have backward teeth come forth at twenty, yea some at thirty and forty. *Query*, of the manner of the coming of them forth. They tell a tale of the old Countess of Desmond, who lived till she was seven-score years old, that she did dentire twice or thrice, casting her old teeth, and others coming in their place.

756. Teeth are much hurt by sweetmeats; and by painting with mercury; and by things over-hot; and by things over-cold; and by rheums. And the pain of the teeth is one of the sharpest of pains.

757. Concerning teeth, these things are to be considered. 1. The preserving of them. 2. The keeping of them white. 3. The drawing of them with least pain. 4. The staying and easing of the tooth-ache. 5. The binding in of artificial teeth, where teeth have been strucken out. 6. And last of all, that great one of restoring teeth in age. The instances that give any likelihood of restoring teeth in age, are the late coming of teeth in some, and the renewing of the beaks in birds, which are commaterial with teeth. *Query*, therefore, more particularly how that

eometh. And again, the renewing of horns. But yet that hath not been known to have been provoked by art; therefore let trial be made, whether horns may be procured to grow in beasts that are not horned, and how? And whether they may be procured to come larger than usual, as to make an ox or a deer have a greater head of horns? And whether the head of a deer, that by age is more spitted, may be brought again to be more branched? for these trials, and the like, will shew, whether by art such hard matter can be called and provoked. It may be tried, also, whether birds may not have something done to them when they are young, whereby they may be made to have greater or longer bills; or greater and longer talons? And whether children may not have some wash, or something to make their teeth better and stronger? Coral is in use as an help to the teeth of children.

Experiments in consort touching the generation and bearing of living creatures in the womb.

758. Some living creatures generate but at certain seasons of the year, as deer, sheep, wild conies, &c. and most sorts of birds and fishes: others at any time of the year, as men; and all domestic creatures, as horses, hogs, dogs, cats, &c. The cause of generation at all seasons seemeth to be fulness: for generation is from redundance. This fulness ariseth from two causes; either from the nature of the creature, if it be hot, and moist, and sanguine; or from plenty of food. For the first, men, horses, dogs, &c. which

breed at all seasons, are full of heat and moisture; doves are the fullest of heat and moisture amongst birds, and therefore breed often; the tame dove almost continually. But deer are a melancholy dry creature, as appeareth by their fearfulness, and the hardness of their flesh. Sheep are a cold creature, as appeareth by their mildness, and for that they seldom drink. Most sort of birds are of a dry substance in comparison of beasts. Fishes are cold. For the second cause, fulness of food; men, kine, swine, dogs, &c. feed full; and we see that those creatures, which being wild, generate seldom, being tame, generate often; which is from warmth, and fulness of food. We find, that the time of going to rut of deer is in September; for that they need the whole summer's feed and grass to make them fit for generation. And if rain come early about the middle of September, they go to rut somewhat the sooner; if drought, somewhat the later. So sheep, in respect of their small heat, generate about the same time, or somewhat before. But for the most part, creatures that generate at certain seasons, generate in the spring; as birds and fishes; for that the end of the winter, and the heat and comfort of the spring prepareth them. There is also another reason why some creatures generate at certain seasons; and that is the relation of their time of bearing to the time of generation; for no creature goeth to generate whilst the female is full; nor whilst she is busy in sitting, or rearing her young. And therefore it is found by experience, that if you take the eggs or young ones out of the

nests of birds, they will fall to generate again three or four times one after another.

759. Of living creatures, some are longer time in the womb, and some shorter. Women go commonly nine months; the cow and the ewe about six months; does go about nine months; mares eleven months; bitches nine weeks; elephants are said to go two years; for the received tradition of ten years is fabulous. For birds there is double inquiry; the distance between the treading or coupling, and the laying of the egg; and again between the egg laid, and the disclosing or hatching. And amongst birds, there is less diversity of time than amongst other creatures; yet some there is; for the hen sitteth but three weeks, the turkey-hen, goose, and duck, a month: *Query*, of others. The cause of the great difference of times amongst living creatures is, either from the nature of the kind, or from the constitution of the womb. For the former, those that are longer in coming to their maturity or growth are longer in the womb; as is chiefly seen in men: and so elephants, which are long in the womb, are long time in coming to their full growth. But in most other kinds, the constitution of the womb, that is, the hardness or dryness thereof, is concurrent with the former cause. For the colt hath about four years of growth; and so the fawn; and so the calf. But whelps, which come to their growth, commonly, within three quarters of a year, are but nine weeks in the womb. As for birds, as there is less diversity amongst them in the time of bringing forth; so there is less diversity in the

time of their growth: most of them coming to their growth within a twelvemonth.

760. Some creatures bring forth many young ones at a burden: as bitches, hares, conies, &c. Some ordinarily but one; as women, lionesses, &c. This may be caused, either by the quantity of sperm required to the producing one of that kind; which if less be required, may admit greater number; if more, fewer: or by the partitions and cells of the womb, which may sever the sperm.

Experiments in consort touching species visible.

761. There is no doubt, but light by refraction will shew greater, as well as things coloured. For like as a shilling in the bottom of the water will shew greater; so will a candle in a lanthorn, in the bottom of the water. I have heard of a practice, that glow-worms in glasses were put in the water to make the fish come. But I am not yet informed, whether when a diver diveth, having his eyes open, and swimmeth upon his back; whether, I say, he seeth things in the air, greater or less. For it is manifest, that when the eye standeth in the finer medium, and the object is in the grosser, things shew greater; but contrariwise, when the eye is placed in the grosser medium, and the object in the finer, how it worketh I know not.

762. It would be well bolted out, whether great refractions may not be made upon reflexions, as well as upon direct beams. For example, we see, that take an empty bason, put an angel of gold, or what

you will, into it; then go so far from the bason, till you cannot see the angel, because it is not in a right line; then fill the bason with water, and you shall see it out of its place, because of the reflexion. To proceed therefore, put a looking glass into a bason of water; I suppose you shall not see the image in a right line, or at equal angles, but aside. I know not whether this experiment may not be extended so, as you might see the image, and not the glass; which for beauty and strangeness were a fine proof: for then you should see the image like a spirit in the air. As for example, if there be a cistern or pool of water, you shall place over against it a picture of the devil, or what you will, so as you do not see the water. Then put a looking-glass in the water: now if you can see the devil's picture aside, not seeing the water, it would look like a devil indeed. They have an old tale in Oxford, that Friar Bacon walked between two steeples: which was thought to be done by glasses, when he walked upon the ground.

Experiments in consort touching impulsion and percussion.

763. A weighty body put into motion is more easily impelled than at first when it resteth. The cause is partly because motion doth discuss the torpor of solid bodies; which, beside their motion of gravity, have in them a natural appetite not to move at all; and partly, because a body that resteth, doth get, by the resistance of the body upon which it resteth, a stronger compression of parts than it hath of itself:

and therefore needeth more force to be put in motion. For if a weighty body be pensile, and hang but by a thread, the percussion will make an impulsion very near as easily as if it were already in motion.

764. A body over-great or over-small, will not be thrown so far as a body of a middle size: so that, it seemeth there must be a commensuration, or proportion between the body moved and the force, to make it move well. The cause is, because to the impulsion there is requisite the force of the body that moveth, and the resistance of the body that is moved: and if the body be too great, it yieldeth too little; and if it be too small, it resisteth too little.

765. It is common experience, that no weight will press or cut so strong, being laid upon a body, as falling or strucken from above. It may be the air hath some part in furthering the percussion; but the chief cause I take to be, for that the parts of the body moved have by impulsion, or by the motion of gravity continued, a compression in them, as well downwards, as they have when they are thrown, or shot through the air, forwards. I conceive also, that the quick loose of that motion preventeth the resistance of the body below: and the priority of the force always is of great efficacy, as appeareth in infinite instances.

Experiment solitary touching titillation.

766. Tickling is most in the soles of the feet, and under the arm-holes, and on the sides. The cause is the thinness of the skin in those parts, joined with the rareness of being touched there: for all tickling is a

light motion of the spirits, which the thinness of the skin, and suddenness and rareness of touch do further: for we see a feather, or a rush, drawn along the lip or cheek, doth tickle; whereas a thing more obtuse, or a touch more hard, doth not. And for suddenness, we see no man can tickle himself: we see also that the palm of the hand, though it hath as thin a skin as the other parts mentioned, yet is not ticklish, because it is accustomed to be touched. Tickling also causeth laughter. The cause may be the emission of the spirits, and so of the breath, by a flight from titillation; for upon tickling we see there is ever a starting or shrinking away of the part to avoid it; and we see also, that if you tickle the nostrils with a feather, or straw, it procureth sneezing; which is a sudden emission of the spirits, that do likewise expel the moisture. And tickling is ever painful, and not well endured.

Experiment solitary touching the scarcity of rain in Egypt.

767. It is strange, that the river of Nilus overflowing, as it doth, the country of Egypt, there should be, nevertheless, little or no rain in that country. The cause must be either in the nature of the water, or in the nature of the air, or of both. In the water, it may be ascribed either unto the long race of the water; for swift-running waters vapour not so much as standing waters; or else to the concoction of the water; for waters well concocted vapour not so much as waters raw; no more than waters upon the fire

do vapour so much after some time of boiling as at the first. And it is true that the water of Nilus is sweeter than other waters in taste; and it is excellent good for the stone, and hypochondriacal melancholy, which sheweth it is lenifying; and it runneth through a country of a hot climate, and flat, without shade, either of woods or hills, whereby the sun must needs have great power to concoct it. As for the air, from whence I conceive this want of showers cometh chiefly, the cause must be, for that the air is of itself thin and thirsty; and as soon as ever it getteth any moisture from the water, it imbibeth and dissipateth it in the whole body of the air, and suffereth it not to remain in vapour, whereby it might breed rain.

Experiment solitary touching clarification.

768. It hath been touched in the title of percolations, namely, such as are inwards, that the whites of eggs and milk do clarify; and it is certain, that in Egypt they prepare and clarify the water of Nile, by putting it into great jars of stone, and stirring it about with a few stamped almonds, wherewith they also besmear the mouth of the vessel; and so draw it off, after it hath rested some time. It were good to try this clarifying with almonds in new beer, or muste, to hasten and perfect the clarifying.

Experiment solitary touching plants without leaves.

769. There be scarce to be found any vegetables, that have branches and no leaves, except you allow coral for one. But there is also in the desarts of

S. Macario in Egypt, a plant which is long, leafless, brown of colour, and branched like coral, save that it closeth at the top. This being set in water within a house, spreadeth and displayeth strangely; and the people thereabout have a superstitious belief, that in the labour of women it helpeth to the easy deliverance.

Experiment solitary touching the materials of glass.

770. The crystalline Venice glass is reported to be a mixture in equal portions of stones brought from Pavia by the river Ticinum, and the ashes of a weed, called by the Arabs kal, which is gathered in a desart between Alexandria and Rosetta; and is by the Egyptians used first for fuel; and then they crush the ashes into lumps like a stone, and so sell them to the Venetians for their glass-works.

Experiment solitary touching prohibition of putrefaction, and the long conservation of bodies.

771. It is strange, and well to be noted, how long carcases have continued uncorrupt, and in their former dimensions, as appeareth in the mummies of Egypt; having lasted, as is conceived, some of them, three thousand years. It is true, they find means to draw forth the brains, and to take forth the entrails, which are the parts aptest to corrupt. But that is nothing to the wonder: for we see what a soft and corruptible substance the flesh of all the other parts of the body is. But it should seem, that, according to our observation and axiom in our hundredth experi-

ment, putrefaction, which we conceive to be so natural a period of bodies, is but an accident; and that matter maketh not that haste to corruption that is conceived. And therefore bodies in shining amber, in quicksilver, in balms, whereof we now speak, in wax, in honey, in gums, and, it may be, in conservatories of snow, &c. are preserved very long. It need not go for repetition, if we resume again that which we said in the aforesaid experiment concerning annihilation; namely, that if you provide against three causes of putrefaction, bodies will not corrupt: the first is, that the air be excluded for that undermineth the body, and conspireth with the spirit of the body to dissolve it. The second is, that the body adjacent and ambient be not commaterial, but merely heterogeneal towards the body that is to be preserved; for if nothing can be received by the one, nothing can issue from the other; such are quicksilver and white amber, to herbs, and flies, and such bodies. The third is, that the body to be preserved be not of that gross that it may corrupt within itself, although no part of it issue into the body adjacent: and therefore it must be rather thin and small, than of bulk. There is a fourth remedy also, which is, that if the body to be preserved be of bulk, as a corpse is, then the body that incloseth it must have a virtue to draw forth, and dry the moisture of the inward body; for else the putrefaction will play within, though nothing issue forth. I remember Livy doth relate, that there were found at a time two coffins of lead in a tomb; whereof the one contained the body of king Numa,

it being some four hundred years after his death: and the other, his books of sacred rites and ceremonies, and the discipline of the pontiffs; and that in the coffin that had the body, there was nothing at all to be seen, but a little light cinders about the sides, but in the coffin that had the books, they were found as fresh as if they had been but newly written, being written on parchment, and covered over with watch-candles of wax three or four fold. By this it seemeth that the Romans in Numa's time were not so good embalmers as the Egyptians were; which was the cause that the body was utterly consumed. But I find in Plutarch and others, that when Augustus Cæsar visited the sepulchre of Alexander the Great in Alexandria, he found the body to keep its dimension; but withal, that notwithstanding all the embalming, which no doubt was the best, the body was so tender, as Cæsar, touching but the nose of it, defaced it. Which maketh me find it very strange, that the Egyptian mummies should be reported to be as hard as stone-pitch; for I find no difference but one, which indeed may be very material, namely that the ancient Egyptian mummies were shrouded in a number of folds of linen, besmeared with gums, in manner of sear-cloth, which it doth not appear was practised upon the body of Alexander.

Experiment solitary touching the abundance of nitre in certain sea-shores.

772. Near the castle of Caty, and by the wells of Assan, in the land of Idumea, a great part of the

way you would think the sea were near at hand, though it be a good distance off: and it is nothing but the shining of the nitre upon the sea sands, such abundance of nitre the shores there do put forth.

Experiment solitary touching bodies that are borne up by water.

773. The Dead Sea, which vomiteth up bitumen, is of that crassitude, as living bodies bound hand and foot cast into it have been borne up, and not sunk; which sheweth, that all sinking into water is but an over-weight of the body put into the water in respect of the water; so that you may make water so strong and heavy, of quicksilver, perhaps, or the like, as may bear up iron; of which I see no use, but imposture. We see also, that all metals, except gold, for the same reason, swim upon quicksilver.

Experiment solitary touching fuel that consumeth little or nothing.

774. It it reported, that at the foot of a hill near the Mare Mortuum there is a black stone, whereof pilgrims make fires, which burneth like a coal, and diminisheth not, but only waxeth brighter and whiter. That it should do so is not strange: for we see iron red hot burneth, and consumeth not; but the strangeness is, that it should continue any time so; for iron, as soon as it is out of the fire, deadeth straightways. Certainly it were a thing of great use and profit, if you could find out fuel that would burn hot, and yet last long: neither am I altogether incredulous

but there may be such candles as they say are made of salamander's wool; being a kind of mineral, which whiteneth also in the burning, and consumeth not. The question is this; flame must be made of somewhat, and commonly it is made of some tangible body which hath weight: but it is not impossible perhaps that it should be made of spirit, or vapour, in a body, which spirit or vapour hath no weight, such as is the matter of ignis fatuus. But then you will say, that that vapour also can last but a short time: to that it may be answered, that by the help of oil, and wax, and other candle-stuff, the flame may continue, and the wick not burn.

Experiment solitary œconomical touching cheap fuel.

775. Sea-coal lasts longer than charcoal; and charcoal of roots, being coaled into great pieces, lasts longer than ordinary charcoal. Turf and peat, and cow-sheards, are cheap fuels, and last long. Small-coal, or brier-coal, poured upon charcoal, make them last longer. Sedge is a cheap fuel to brew or bake with: the rather because it is good for nothing else. Trial would be made of some mixture of sea-coal with earth or chalk; for if that mixture be, as the sea-coal men use it, privily, to make the bulk of the coal greater, it is deceit; but if it be used purposely, and be made known, it is saving.

Experiment solitary touching the gathering of wind for freshness.

776. It is at this day in use in Gaza, to couch

potsherds or vessels of earth in their walls, to gather the wind from the top, and to pass it down in spouts into rooms. It is a device for freshness in great heats: and it is said, there are some rooms in Italy and Spain for freshness, and gathering the winds and air in the heats of summer; but they be but pennings of the winds, and enlarging them again, and making them reverberate, and go round in circles, rather than this device of spouts in the wall.

Experiment solitary touching the trials of airs.

777. There would be used much diligence in the choice of some bodies and places, as it were, for the tasting of air; to discover the wholesomeness or unwholesomeness, as well of seasons, as of the seats of dwellings. It is certain, that there be some houses wherein confitures and pies will gather mould more than in others. And I am persuaded that a piece of raw flesh or fish will sooner corrupt in some airs than in others. They be noble experiments that can make this discovery; for they serve for a natural divination of seasons, better than the astronomers can by their figures: and again, they teach men where to chuse their dwelling for their better health.

Experiment solitary touching increasing of milk in milch beasts.

778. There is a kind of stone about Bethlehem, which they grind to powder, and put into water, whereof cattle drink, which maketh them give more milk. Surely there would be some better trials made

of mixtures of water in ponds for cattle, to make them more milch, or to fatten them, or to keep them from murrain. It may be chalk and nitre are of the best.

Experiment solitary touching sand of the nature of glass.

779. It is reported, that in the valley near the mountain Carmel in Judea there is a sand, which of all other hath most affinity with glass: insomuch as other minerals laid in it turn to a glassy substance without the fire; and again, glass put into it turneth into the mother sand. The thing is very strange, if it be true: and it is likeliest to be caused by some natural furnace or heat in the earth: and yet they do not speak of any eruption of flames. It were good to try in glass-works, whether the crude materials of glass, mingled with glass already made, and remolten, do not facilitate the making of glass with less heat.

Experiment solitary touching the growth of coral.

780. In the sea, upon the south-west of Sicily, much coral is found. It is a submarine plant. It hath no leaves: it brancheth only when it is under water; it is soft, and green of colour; but being brought into the air, it becometh hard and shining red, as we see. It is said also to have a white berry; but we find it not brought over with the coral. Belike it is cast away as nothing worth: inquire better of it, for the discovery of the nature of the plant.

Experiment solitary touching the gathering of manna.

781. The manna of Calabria is the best, and in most plenty. They gather it from the leaf of the mulberry-tree; but not of such mulberry-trees as grow in the vallies. And manna falleth upon the leaves by night, as other dews do. It should seem, that before those dews come upon trees in the vallies, they dissipate and cannot hold out. It should seem, also, the mulberry-leaf itself hath some coagulating virtue, which inspissateth the dew, for that it is not found upon other trees: and we see by the silk-worm, which feedeth upon that leaf, what a dainty smooth juice it hath; and the leaves also, especially of the black mulberry, are somewhat bristly, which may help to preserve the dew. Certainly it were not amiss to observe a little better the dews that fall upon trees, or herbs growing on mountains; for it may be many dews fall, that spend before they come to the vallies. And I suppose, that he that would gather the best May-dew for medicine, should gather it from the hills.

Experiment solitary touching the correcting of wine.

728. It is said they have a manner to prepare their Greek wines, to keep them from fuming and inebriating, by adding some sulphur or alum: whereof the one is unctuous, and the other is astringent. And certain it is, that those two natures do best repress fumes. This experiment would be transferred unto other wine and strong beer, by putting in some like

substances while they work; which may make them both to fume less, and to inflame less.

Experiment solitary touching the materials of wildfire.

783. It is conceived by some, not improbably, that the reason why wild fires, whereof the principal ingredient is bitumen, do not quench with water, is, for that the first concretion of bitumen is a mixture of a fiery and watery substance; so is not sulphur, This appeareth, for that in the place near Puteoli, which they call the court of Vulcan, you shall hear under the earth a horrible thundering of fire and water conflicting together; and there break forth also spouts of boiling water. Now that place yieldeth great quantities of bitumen; whereas Ætna and Vesuvius, and the like, which consist upon sulphur, shoot forth smoke, and ashes, and pumice, but no water. It is reported also, that bitumen mingled with lime, and put under water, will make as it were an artificial rock; the substance becometh so hard.

Experiment solitary touching plaster growing as hard as marble.

784. There is a cement, compounded of flour, whites of eggs, and stone powdered, that becometh hard as marble: wherewith Piscina Mirabilis, near Cuma, is said to have the walls plastered. And it is certain and tried, that the powder of loadstone and flint, by the addition of whites of eggs, and gum-dragon, made into paste, will in a few days harden to the hardness of a stone.

Experiment solitary touching judgment of the cure in some ulcers and hurts.

785. It hath been noted by the ancients, that in full or impure bodies, ulcers or hurts in the legs are hard to cure, and in the head more easy. The cause is, for that ulcers or hurts in the legs require desiccation, which by the defluxion of humours to the lower parts is hindered: whereas hurts and ulcers in the head require it not; but contrariwise dryness maketh them more apt to consolidate. And in modern observation, the like difference hath been found between Frenchmen and Englishmen; whereof the one's constitution is more dry, and the other's more moist. And therefore a hurt of the head is harder to cure in a Frenchman, and of the leg in an Englishman.

Experiment solitary touching the healthfulness or unhealthfulness of the southern wind.

786. It hath been noted by the ancients, that southern winds, blowing much, without rain, do cause a feverous disposition of the year; but with rain, not. The cause is, for that southern winds do of themselves qualify the air, to be apt to cause fevers; but when showers are joined, they do refrigerate in part, and check the sultry heat of the southern wind. Therefore this holdeth not in the sea coasts, because the vapour of the sea, without showers, doth refresh.

Experiment solitary touching wounds.

787. It hath been noted by the ancients, that wounds which are made with brass heal more easily

than wounds made with iron. The cause is, for hat brass hath in itself a sanative virtue; and so in the very instant helpeth somewhat: but iron is corrosive and not sanative. And therefore it were good, that the instruments which are used by chirurgeons about wounds, were rather of brass than iron.

Experiment solitary touching mortification by cold.

788. In the cold countries, when men's noses and ears are mortified, and, as it were, gangrened with cold, if they come to a fire they rot off presently. The cause is, for that the few spirits that remain in those parts, are suddenly drawn forth, and so putrefaction is made complete. But snow put upon them helpeth: for that it preserveth those spirits that remain, till they can revive; and besides, snow hath in it a secret warmth: as the monk proved out of the text; "qui dat nivem sicut lanam, gelu sicut cineres spargit." Whereby he did infer, that snow did warm like wool, and frost did fret like ashes. Warm water also doth good; because by little and little it openeth the pores, without any sudden working upon the spirits. This experiment may be transferred to the cure of gangrenes, either coming of themselves, or induced by too much applying of opiates; wherein you must beware of dry heat, and resort to things that are refrigerant, with an inward warmth, and virtue of cherishing.

Experiment solitary touching weight.

789. Weigh iron and aqua fortis severally; then

dissolve the iron in the aqua fortis, and weigh the dissolution; and you shall find it to bear as good weight as the bodies did severally: notwithstanding a good deal of waste by a thick vapour that issueth during the working; which sheweth that the opening of a body doth increase the weight. This was tried once or twice, but I know not whether there were any error in the trial.

Experiment solitary touching the super-natation of bodies.

790. Take of aqua fortis two ounces, of quicksilver two drams, for that charge the aqua fortis will bear, the dissolution will not bear a flint as big as a nutmeg; yet, no doubt, the encreasing of the weight of water will encrease its power of bearing; as we see brine, when it is salt enough, will bear an egg. And I remember well a physician, that used to give some mineral baths for the gout, &c. and the body, when it was put into the bath, could not get down so easily as in ordinary water. But it seemeth the weight of the quicksilver more than the weight of a stone, doth not compense the weight of a stone more than the weight of the aqua fortis.

Experiment solitary touching the flying of unequal bodies in the air.

791. Let there be a body of unequal weight, as of wood and lead, or bone and lead, if you throw it from you with the light end forward, it will turn, and the weightier end will recover to be forwards;

unless the body be over-long. The cause is for that the more dense body hath a more violent pressure of the parts from the first impulsion; which is the cause, though heretofore not found out, as hath been often said, of all violent motions; and when the hinder part moveth swifter, for that it less endureth pressure of parts, than the forward part can make way for it, it must needs be that the body turn over: for, turned, it can more easily draw forward the the lighter part. Galilæus noteth it well, that if an open trough wherein water is, be driven faster than the water can follow, the water gathereth upon an heap towards the hinder end, where the motion began, which he supposeth, holding confidently the motion of the earth, to be the cause of the ebbing and flowing of the ocean: because the earth overrunneth the water. Which theory, though it be false, yet the first experiment is true. As for the inequality of the pressure of parts, it appeareth manifestly in this; that if you take a body of stone or iron, and another of wood, of the same magnitude and shape, and throw them with equal force, you cannot possibly throw the wood so far as the stone or iron.

Experiment solitary touching water, that it may be the medium of sounds.

792. It is certain, as it hath been formerly in part touched, that water may be the medium of sounds. If you dash a stone against a stone in the bottom of the water, it maketh a sound. So a long

pole struck upon gravel in the bottom of the water maketh a sound. Nay, if you should think that the sound cometh up by the pole, and not by the water, you shall find that an anchor let down by a rope maketh a sound: and yet the rope is no solid body whereby the sound can ascend.

Experiment solitary of the flight of the spirits upon odious objects.

793. All objects of the senses which are very offensive, do cause the spirits to retire: and upon their flight, the parts are, in some degree, destitute; and so there is induced in them a trepidation and horror. For sounds, we see that the grating of a saw, or any very harsh noise, will set the teeth on edge, and make all the body shiver. For tastes, we see that in the taking of a potion or pills, the head and the neck shake. For odious smells, the like effect followeth, which is less perceived, because there is a remedy at hand by stopping of the nose; but in horses, that can use no such help, we see the smell of a carrion, especially of a dead horse, maketh them fly away, and take on almost as if they were mad. For feeling, if you come out of the sun suddenly into a shade, there followeth a chillness or shivering in all the body. And even in sight, which hath in effect no odious object, coming into sudden darkness, induceth an offer to shiver.

Experiment solitary touching the super-reflexion of echos.

794. There is in the city of Ticinum in Italy, a church which hath windows only from above: it is in length an hundred feet, in breadth twenty feet, and in height near fifty; having a door in the midst. It reporteth the voice twelve or thirteen times, if you stand by the close end wall over-against the door. The echo fadeth, and dieth by little and little, as the echo at Pont-Charenton doth. And the voice soundeth as if it came from above the door. And if you stand at the lower end, or on either side of the door, the echo holdeth; but if you stand in the door, or in the midst just over-against the door, not. Note, that all echos sound better against old walls than new; because they are more dry and hollow.

Experiment solitary touching the force of imagination, imitating that of the sense.

795. Those effects which are wrought by the percussion of the sense, and by things in fact, are produced likewise in some degree by the imagination. Therefore if a man see another eat sour or acid things, which set the teeth on edge, this object tainteth the imagination. So that he that seeth the thing done by another, hath his own teeth also set on edge. So if a man see another turn swiftly and long, or if he look upon wheels that turn, himself waxeth turn-sick. So if a man be upon an high place without rails or good hold, except he be used

to it, he is ready to fall: for imagining a fall, it putteth his spirits into the very action of a fall. So many upon the seeing of others bleed, or strangled, or tortured, themselves are ready to faint, as if they bled, or were in strife.

Experiment solitary touching preservation of bodies.

796. Take a stock-gilly-flower, and tie it gently upon a stick, and put them both into a stoop-glass full of quicksilver, so that the flower be covered: then lay a little weight upon the top of the glass that may keep the stick down; and look upon them after four or five days; and you shall find the flower fresh, and the stalk harder and less flexible than it was. If you compare it with another flower gathered at the same time, it will be the more manifest. This sheweth, that bodies do preserve excellently in quicksilver; and not preserve only, but by the coldness of the quicksilver indurate; for the freshness of the flower may be merely conservation; which is the more to be observed, because the quicksilver presseth the flower; but the stiffness of the stalk cannot be without induration, from the cold, as it seemeth, of the quicksilver.

Experiment solitary touching the growth or multiplying of metals.

797. It is reported by some of the ancients, that in Cyprus there is a kind of iron, that being cut into little pieces, and put into the ground, if it be well

watered, will increase into greater pieces. This is certain, and known of old, that lead will multiply and increase, as hath been seen in old statues of stone which have been put in cellars; the feet of them being bound with leaden bands; where, after a time, there appeared, that the lead did swell; insomuch as it hanged upon the stone like warts.

Experiment solitary touching the drowning of the more base metal in the more precious.

798. I call drowning of metals, when that the baser metal is so incorporate with the more rich as it can by no means be separated again; which is a kind of version, though false: as if silver should be inseparably incorporated with gold: or copper and lead with silver. The ancient electrum had in it a fifth of silver to the gold, and made a compound metal, as fit for most uses as gold, and more resplendent, and more qualified in some other properties; but then that was easily separated. This to do privily, or to make the compound pass for the rich metal simple, is an adulteration or counterfeiting: but if it be done avowedly, and without disguising, it may be a great saving of the richer metal. I remember to have heard of a man skilful in metals, that a fifteenth part of silver incorporated with gold will not be recovered by any water of separation, except you put a greater quantity of silver to draw to it the less; which, he said, is the last refuge in separations. But that is a tedious way, which no

man, almost, will think on. This would be better inquired: and the quantity of the fifteenth turned to a twentieth; and likewise with some little additional, that may further the intrinsic incorporation. Note, that silver in gold will be detected, by weight, compared with the dimension; but lead in silver, lead being the weightier metal, will not be detected, if you take so much the more silver as will countervail the over-weight of the lead.

Experiment solitary touching fixation of bodies.

799. Gold is the only substance which hath nothing in it volatile, and yet melteth without much difficulty. The melting sheweth that it is not jejune, or scarce in spirit. So that the fixing of it is not want of spirit to fly out, but the equal spreading of the tangible parts, and the close coacervation of them: whereby they have the less appetite, and no means at all to issue forth. It were good therefore to try, whether glass remolten do lose any weight? for the parts in glass are evenly spread; but they are not so close as in gold; as we see by the easy admission of light, heat, and cold; and by the smallness of the weight. There be other bodies fixed, which have little or no spirit, so as there is nothing to fly out; as we see in the stuff whereof coppels are made, which they put into furnaces, upon which fire worketh not; so that there are three causes of fixation; the even spreading both of the spirits and tangible parts, the closeness of the tangible parts, and the jejuneness or

extreme comminution of spirits: of which three, the two first may be joined with a nature liquefiable, the last not.

Experiment solitary touching the restless nature of things in themselves, and their desire to change.

800. It is a profound contemplation in nature, to consider of the emptiness, as we may call it, or insatisfaction of several bodies, and of their appetite to take in others. Air taketh in lights, and sounds, and smells, and vapours; and it is most manifest, that it doth it with a kind of thirst, as not satisfied with its own former consistence; for else it would never receive them in so suddenly and easily. Water, and all liquors do hastily receive dry and more terrestrial bodies, proportionable: and dry bodies, on the other side, drink in waters and liquors: so that, as it was well said by one of the ancients, of earthy and watery substances, one is a glue to another. Parchment, skins, cloth, &c. drink in liquors, though themselves be entire bodies, and not comminuted, as sand and ashes, nor apparently porous: metals themselves do receive in readily strong waters; and strong waters likewise do readily pierce into metals and stones: and that strong water will touch upon gold, that will not touch upon silver, and *e converso*. And gold, which seemeth by the weight to be the closest and most solid body, doth greedily drink in quicksilver. And it seemeth, that this reception of other bodies is not violent: for it is many times reciprocal

and as it were with consent. Of the cause of this, and to what axiom it may be referred, consider attentively; for as for the petty assertion, that matter is like a common strumpet, that desireth all forms, it is but a wandering notion. Only flame doth not content itself to take in any other body, but either to overcome and turn another body into itself, as by victory; or itself to die, and go out.

NATURAL HISTORY.

CENTURY IX.

Experiments in consort touching perception in bodies insensible, tending to natural divination or subtile trials.

It is certain, that all bodies whatsoever, though they have no sense, yet they have perception: for when one body is applied to another, there is a kind of election to embrace that which is agreeable, and to exclude or expel that which is ingrate: and whether the body be alterant, or altered, evermore a perception precedeth operation; for else all bodies would be alike one to another. And sometimes this perception, in some kind of bodies, is far more subtile than the sense; so that the sense is but a dull thing in comparison of it: we see a weather-glass will find the least difference of the weather, in heat, or cold, when men find it not. And this perception also is sometimes at distance, as well as upon the touch; as when the loadstone draweth iron, or flame fireth naphtha of Babylon, a great distance off. It is therefore a subject of a very noble inquiry, to inquire of the more subtile perceptions: for it is another key to open nature, as well as the sense, and sometimes

better. And besides, it is a principal means of natural divination; for that which in these perceptions appeareth early, in the great effects cometh long after. It is true also, that it serveth to discover that which is hid, as well as to foretel that which is to come, as it is in many subtile trials; as to try whether seeds be old or new, the sense cannot inform; but if you boil them in water, the new seeds will sprout sooner: and so of water, the taste will not discover the best water; but the speedy consuming of it, and many other means, which we have heretofore set down, will discover it. So in all physiognomy, the lineaments of the body will discover those natural inclinations of the mind which dissimulation will conceal, or discipline will suppress. We shall therefore now handle only those two perceptions, which pertain to natural divination and discovery; leaving the handling of perception in other things to be disposed elsewhere. Now it is true, that divination is attained by other means; as if you know the causes, if you know the concomitants, you may judge of the effect to follow: and the like may be said of discovery; but we tie ourselves here to that divination and discovery chiefly, which is caused by an early or subtile perception.

The aptness or propension of air, or water, to corrupt or putrify, no doubt, is to be found before it break forth into manifest effects of diseases, blastings, or the like. We will therefore set down some prognostics of pestilential and unwholesome years.

801. The wind blowing much from the south

without rain, and worms in the oak-apple, have been spoken of before. Also the plenty of frogs, grasshoppers, flies, and the like creatures bred of putrefaction, doth portend pestilential years.

802. Great and early heats in the spring, and namely in May, without winds, portend the same; and generally so do years with little wind or thunder.

803. Great droughts in summer lasting till towards the end of August, and some gentle showers upon them, and then some dry weather again, do portend a pestilent summer the year following: for about the end of August all the sweetness of the earth, which goeth into plants and trees, is exhaled, and much more if the August be dry, so that nothing then can breathe forth of the earth but a gross vapour, which is apt to corrupt the air: and that vapour, by the first showers, if they be gentle, is released, and cometh forth abundantly. Therefore they that come abroad soon after those showers, are commonly taken with sickness: and in Africa, nobody will stir out of doors after the first showers But if the showers come vehemently, then they rather wash and fill the earth, than give it leave to breathe forth presently. But if dry weather come again, then it fixeth and continueth the corruption of the air, upon the first showers begun; and maketh it of ill influence, even to the next summer; except a very frosty winter discharge it, which seldom succeedeth such droughts.

804. The lesser infections, of the small-pox, pur-

ple fevers, agues, in the summer precedent, and hovering all winter, do portend a great pestilence in the summer following; for putrefaction doth not rise to its height at once.

805. It were good to lay a piece of raw flesh or fish in the open air; and if it putrify quickly, it is a sign of a disposition in the air to putrefaction. And because you cannot be informed whether the putrefaction be quick or late, except you compare this experiment with the like experiment in another year it were not amiss in the same year, and at the same time, to lay one piece of flesh or fish in the open air, and another of the same kind and bigness within doors: for I judge, that if a general disposition be in the air to putrify, the flesh, or fish, will sooner putrify abroad where the air hath more power, than in the house, where it hath less, being many ways corrected. And this experiment would be made about the end of March: for that season is likeliest to discover what the winter hath done, and what the summer following will do, upon the air. And because the air, no doubt, receiveth great tincture and infusion from the earth; it were good to try that exposing of flesh or fish, both upon a stake of wood some height above the earth, and upon the flat of the earth.

806. Take May-dew, and see whether it putrify quickly or no; for that likewise may disclose the quality of the air, and vapour of the earth, more or less corrupted.

807. A dry March, and a dry May, portend a

wholesome summer, if there be a showering April between: but otherwise it is a sign of a pestilential year.

808. As the discovery of the disposition of the air is good for the prognostics of wholesome and unwholesome years; so it is of much more use, for the choice of places to dwell in: at the least, for lodges, and retiring places for health: for mansion-houses respect provisions as well as health, wherein the experiments above-mentioned may serve.

809. But for the choice of places, or seats, it is good to make trial, not only of aptness of air to corrupt, but also of the moisture and dryness of the air, and the temper of it in heat or cold; for that may concern health diversly. We see that there be some houses, wherein sweet-meats will relent, and baked meats will mould, more than in others; and wainscots will also sweat more; so that they will almost run with water; all which, no doubt, are caused chiefly by the moistness of the air in those seats. But because it is better to know it before a man buildeth his house, than to find it after, take the experiments following.

810. Lay wool, or a sponge, or bread, in the place you will try, comparing it with some other places; and see whether it doth not moisten, and make the wool, or sponge, &c. more ponderous than the other: and if it do, you may judge of that place, as situate in a gross and moist air.

811. Because it is certain, that in some places, either by the nature of the earth, or by the situation

of woods and hills, the air is more unequal than in others; and inequality of air is ever an enemy to health; it were good to take two weather-glasses, matches in all things, and to set them, for the same hours of one day, in several places, where no shade is, nor inclosures; and to mark when you set them, how far the water cometh; and to compare them, when you come again, how the water standeth then; and if you find them unequal, you may be sure that the place where the water is lowest is in the warmer air, and the other in the colder. And the greater the inequality be, of the ascent or decent of the water, the greater is the inequality of the temper of the air.

812. The predictions likewise of cold and long winters, and hot and dry summers, are good to be known, as well for the discovery of the causes, as for divers provisions. That of plenty of haws, and hips, and brier-berries, hath been spoken of before. If wainscot, or stone, that have used to sweat, be more dry in the beginning of winter, or the drops of the eaves of houses come more slowly down than they use, it portendeth a hard and frosty winter. The cause is, for that it sheweth an inclination of the air to dry weather, which in winter is ever joined with frost.

813. Generally a moist and cool summer portendeth a hard winter. The cause is, for that the vapours of the earth are not dissipated in the summer by the sun; and so they rebound upon the winter.

814. A hot and dry summer, and autumn, and

especially if the heat and drought extend far into September, portendeth an open beginning of winter; and colds to succeed toward the latter part of the winter, and the beginning of the spring: for till then the former heat and drought bear the sway, and the vapours are not sufficiently multiplied.

815. An open and warm winter portendeth a hot and dry summer; for the vapours disperse into the winter showers; whereas cold and frost keepeth them in, and transporteth them into the late spring and summer following.

816. Birds that use to change countries at certain seasons, if they come earlier, do shew the temperature of weather, according to that country whence they came: as the winter birds, namely, woodcocks, feldfares, &c. if they come earlier, and out of the northern countries, with us shew cold winters. And if it be in the same country, then they shew a temperature of season, like unto that season in which they come: as swallows, bats, cuckoos, &c. that come towards summer, if they come early, shew a hot summer to follow.

817. The prognostics, more immediate of weather to follow soon after, are more certain than those of seasons. The resounding of the sea upon the shore; and the murmur of winds in the woods, without apparent wind, shew wind to follow; for such winds breathing chiefly out of the earth, are not at the first perceived, except they be pent by water or wood. And therefore a murmur out of caves likewise portendeth as much.

818. The upper regions of the air perceive the collection of the matter of tempests and winds, before the air here below: and therefore the obscuring of the smaller stars, is a sign of tempest following. And of this kind you shall find a number of instances in our inquisition De ventis.

819. Great mountains have a perception of the disposition of the air to tempests, sooner than the vallies or plains below: and therefore they say in Wales, when certain hills have their night-caps on, they mean mischief. The cause is, for that tempests, which are for the most part bred above in the middle region, as they call it, are soonest perceived to collect in the places next it.

820. The air, and fire, have subtile perceptions of wind rising, before men find it. We see the trembling of a candle will discover a wind that otherwise we do not feel; and the flexuous burning of flames doth shew the air beginneth to be unquiet; and so do coals of fire by casting off the ashes more than they use. The cause is, for that no wind at the first, till it hath struck and driven the air, is apparent to the sense; but flame is easier to move than air: and for the ashes, it is no marvel, though wind unperceived shake them off; for we usually try which way the wind bloweth, by casting up grass, or chaff, or such light things into the air.

821. When wind expireth from under the sea, as it causeth some resounding of the water, whereof we spake before, so it causeth some light motions of bubbles, and white circles of froth. The cause is, for

that the wind cannot be perceived by the sense, until there be an eruption of a great quantity from under the water; and so it getteth into a body: whereas in the first putting up it cometh in little portions.

822. We spake of the ashes that coals cast off; and of grass and chaff carried by the wind; so any light thing that moveth when we find no wind, sheweth a wind at hand; as when feathers, or down of thistles, fly to and fro in the air.

For prognostics of weather from living creatures it is to be noted, that creatures that live in the open air, sub dio, must needs have a quicker impression from the air, than men that live most within doors; and especially birds who live in the air freest and clearest; and are aptest by their voice to tell tales what they find, and likewise by the motion of their flight to express the same.

823. Water-fowls, as sea-gulls, moor-hens, &c. when they flock and fly together from the sea towards the shores; and contrariwise, land-birds, as crows, swallows, &c. when they fly from the land to the waters, and beat the waters with their wings, do foreshew rain and wind. The cause is, pleasure that both kinds take in the moistness and density of the air; and so desire to be in motion, and upon the wing, whithersoever they would otherwise go; for it is no marvel, that water-fowl do joy most in that air which is likest water: and land-birds also, many of them, delight in bathing, and moist air. For the same reason also, many birds do prune their feathers; and geese do gaggle; and crows seem to call upon rain:

all which is but the comfort they seem to receive in the relenting of the air.

824. The heron, when she soareth high, so as sometimes she is seen to pass over a cloud, sheweth winds: but kites flying aloft shew fair and dry weather. The cause may be, for that they both mount most into the air of that temper wherein they delight: and the heron being a water-fowl, taketh pleasure in the air that is condensed; and besides, being but heavy of wing, needeth the help of the grosser air. But the kite affecteth not so much the grossness of the air, as the cold and freshness thereof: for being a bird of prey, and therefore hot, she delighteth in the fresh air, and many times, flieth against the wind, as trouts and salmons swim against the stream. And yet it is true also, that all birds find an ease in the depth of the air, as swimmers do in a deep water. And therefore when they are aloft, they can uphold themselves with their wings spread, scarce moving them.

825. Fishes, when they play towards the top of the water, do commonly foretel rain. The cause is, for that a fish hating the dry, will not approach the air till it groweth moist; and when it is dry, will fly it, and swim lower.

826. Beasts do take comfort generally in a moist air: and it maketh them eat their meat better; and therefore sheep will get up betimes in the morning to feed against rain: and cattle, and deer, and conies, will feed hard before rain; and a heifer will put up her nose, and snuff in the air against rain.

827. The trefoil against rain swelleth in the stalk; and so standeth more upright; for by wet, stalks do erect, and leaves bow down. There is a small red flower in the stubble-fields, which country-people call the wincopipe; which if it open in the morning, you may be sure of a fair day to follow.

828. Even in men, aches, and hurts, and corns, do engrieve either towards rain, or towards frost: for the one maketh the humours more to abound; and the other maketh them sharper. So we see both extremes bring the gout.

829. Worms, vermin, &c. do foreshew likewise rain: for earthworms will come forth, and moles will cast up more, and fleas bite more, against rain.

830. Solid bodies likewise foreshew rain. As stones and wainscot, when they sweat: and boxes and pegs of woods, when they draw and wind hard; though the former be but from an outward cause; for that the stone, or wainscot, turneth and beateth back the air against itself; and the latter is an inward swelling of the body of the wood itself.

Experiment solitary touching the nature of appetite in the stomach.

831. Appetite is moved chiefly by things that are cold and dry; the cause is, for that cold is a kind of indigence of nature, and calleth upon supply; and so is dryness: and therefore all sour things, as vinegar, juice of lemons, oil of vitriol, &c. provoke

appetite. And the disease which they call appetitus caninus, consisteth in the matter of an acid and glassy phlegm in the mouth of the stomach. Appetite is also moved by sour things; for that sour things induce a contraction in the nerves placed in the mouth of the stomach, which is a great cause of appetite. As for the cause why onions, and salt, and pepper, in baked meats, move appetite, it is by vellication of those nerves; for motion whetteth. As for wormwood, olives, capers, and others of that kind, which participate of bitterness, they move appetite by abstersion. So as there be four principal causes of appetite; the refrigeration of the stomach joined with some dryness, contraction, vellication, and abstersion; besides hunger; which is an emptiness; and yet over-fasting doth, many times, cause the appetite to cease; for that want of meat maketh the stomach draw humours, and such humours as are light and choleric, which quench appetite most.

Experiment solitary touching sweetness of odour from the rainbow.

832. It hath been observed by the ancients, that where a rainbow seemeth to hang over, or to touch, there breatheth forth a sweet smell. The cause is, for that this happeneth but in certain matters, which have in themselves some sweetness; which the gentle dew of the rainbow doth draw forth: and the like do soft showers; for they also make the ground sweet: but none are so delicate as the dew of the rainbow where it falleth, It may be also that the

water itself hath some sweetness; for the rainbow consisteth of a glomeration of small drops, which cannot possibly fall but from the air that is very low; and therefore may hold the very sweetness of the herbs and flowers, as a distilled water; for rain, and other dew that fall from high, cannot preserve the smell, being dissipated in the drawing up: neither do we know, whether some water itself may not have some degree of sweetness. It is true, that we find it sensibly in no pool, river, nor fountain; but good earth, newly turned up, hath a freshness and good scent; which water, if it be not too equal, for equal objects never move the sense, may also have. Certain it is, that bay-salt, which is but a kind of water congealed, will sometimes smell like violets.

Experiment solitary touching sweet smells.

833. To sweet smells heat is requisite to concoct the matter; and some moisture to spread the breath of them. For heat, we see that woods and spices are more odorate in the hot countries than in the cold: for moisture, we see that things too much dried lose their sweetness: and flowers growing, smell better in a morning or evening than at noon. Some sweet smells are destroyed by approach to the fire; as violets, wall-flowers, gilly-flowers, pinks; and generally all flowers that have cool and delicate spirits. Some continue both on the fire, and from the fire; as rose-water, &c. Some do scarce come forth, or at least not so pleasantly, as by means of the fire; as juniper, sweet gums, &c. and all smells that

are enclosed in a fast body: but generally those smells are the most grateful, where the degree of heat is small; or where the strength of the smell is allayed; for these things do rather woo the sense, than satiate it. And therefore the smell of violets and roses exceedeth in sweetness that of spices and gums; and the strongest sort of smells are best in a weft afar off.

Experiment solitary touching the corporeal substance of smells.

834. It is certain, that no smell issueth but with emission of some corporeal substance; not as it is in light, and colours, and in sounds. For we see plainly, that smell doth spread nothing that distance that the other do. It is true, that some woods of oranges, and heaths of rosemary, will smell a great way into the sea, perhaps twenty miles; but what is that, since a peal of ordnance will do as much, which moveth in a small compass? Whereas those woods and heaths are of vast spaces; besides, we see that smells do adhere to hard bodies; as in perfuming of gloves, &c. which showeth them corporeal; and do last a great while, which sounds and light do not.

Experiment solitary touching fetid and fragrant odours.

835. The excrements of most creatures smell ill; chiefly to the same creature that voideth them: for we see, besides that of man, that pigeons and horses

thrive best, if their houses and stables be kept sweet, and so of cage birds: and the cat burieth that which she voideth: and it holdeth chiefly in those beasts which feed upon flesh. Dogs almost only of beasts delight in fetid odours, which sheweth there is somewhat in their sense of smell differing from the smells of other beasts. But the cause why excrements smell ill, is manifest; for that the body itself rejecteth them; much more the spirits: and we see that those excrements that are of the first digestion, smell the worst; as the excrements from the belly; those that are from the second digestion less ill: as urine; and those that are from the third, yet less; for sweat is not so bad as the other two; especially of some persons, that are full of heat. Likewise most putrefactions are of an odious smell: for they smell either fetid or mouldy. The cause may be, for that putrefaction doth bring forth such a consistence, as is most contrary to the consistence of the body whilst it is sound: for it is a mere dissolution of that form. Besides, there is another reason, which is profound: and it is, that the objects that please any of the senses have all some equality, and, as it were, order in their composition; but where those are wanting, the object is ever ingrate. So mixture of many disagreeing colours is ever unpleasant to the eye: mixture of discordant sounds is unpleasant to the ear: mixture, or hotch-potch of many tastes, is unpleasant to the taste: harshness and ruggedness of bodies is unpleasant to the touch: now it is certain, that all putrefaction,

being a dissolution of the first form, is a mere confusion and unformed mixture of the part. Nevertheless it is strange, and seemeth to cross the former observation, that some putrefactions and excrements do yield excellent odours, as civet and musk; and, as some think, ambergrease: for divers take it, though improbably, to come from the sperm of fish: and the moss we spake of from apple-trees, is little better than an excretion. The reason may be, for that there passeth in the excrements, and remaineth in the putrefactions, some good spirits; especially where they proceed from creatures that are very hot. But it may be also joined with a further cause, which is more subtile; and it is, that the senses love not to be over-pleased, but to have a commixture of somewhat that is in itself ingrate. Certainly, we see how discords in music, falling upon concords, make the sweetest strains: and we see again, what strange tastes delight the taste; as red herrings, caviary, parmesan, &c. And it may be the same holdeth in smells: for those kind of smells that we have mentioned, are all strong, and do pull and vellicate the sense. And we find also, that places where men urine, commonly have some smell of violets: and urine, if one hath eaten nutmeg, hath so too.

The slothful, general, and indefinite contemplations, and notions, of the elements and their conjugations; of the influences of heaven; of heat, cold, moisture, drought, qualities active, passive, and the like, have swallowed up the true passages, and pro-

cesses, and affects, and consistences of matter and natural bodies. Therefore they are to be set aside, being but notional and ill limited; and definite axioms are to be drawn out of measured instances: and so assent to be made to the more general axioms by scale. And of these kinds of processes of natures and characters of matter, we will now set down some instances.

Experiment solitary touching the causes of putrefaction.

836. All putrefactions come chiefly from the inward spirits of the body; and partly also from the ambient body, be it air, liquor, or whatsoever else. And this last by two means: either by ingress of the substance of the ambient body into the body putrified; or by excitation and solicitation of the body putrified, and the parts thereof, by the body ambient. As for the received opinion, that putrefaction is caused, either by cold, or peregrine and preternatural heat, it is but nugation: for cold in things inanimate, is the greatest enemy that is to putrefaction; though it extinguisheth vivification, which ever consisteth in spirits attenuate, which the cold doth congeal and coagulate. And as for the peregrine heat, it is thus far true, that if the proportion of the adventive heat be greatly predominant to the natural heat and spirits of the body, it tendeth to dissolution, or notable alteration. But this is wrought by emission, or suppression, or suffocation, of the native spirits; and also by the disordination and discomposture of the tangible parts, and

other passages of nature, and not by a conflict of heats.

Experiment solitary touching bodies unperfectly mixed.

837. In versions, or main alterations of bodies, there is a medium between the body, as it is at first, and the body resulting; which medium is corpus imperfecte mistum, and is transitory, and not durable; as mists, smokes, vapours, chylus in the stomach, living creatures in the first vivification; and the middle action, which produceth such imperfect bodies, is fitly called, by some of the ancients, inquination, or inconcoction, which is a kind of putrefaction: for the parts are in confusion, till they settle one way or other.

Experiment solitary touching concoction and crudity.

838. The word concoction, or digestion, is chiefly taken into use from living creatures and their organs; and from thence extended to liquors and fruits, &c. Therefore they speak of meat concocted; urine and excrements concocted; and the four digestions, in the stomach, in the liver, in the arteries and nerves, and in the several parts of the body, are likewise called concoctions: and they are all made to be the works of heat; all which notions are but ignorant catches of a few things, which are most obvious to men's observations. The constantest notion of concoction is, that it should signify the degrees of alteration, of one body into another, from crudity to

perfect concoction; which is the ultimity of that action or process; and while the body to be converted and altered is too strong for the efficient that should convert or alter it, whereby it resisteth and holdeth fast in some degree the first form or consistence, it is all that while crude and inconcoct; and the process is to be called crudity and inconcoction. It is true, that concoction is in great part the work of heat, but not the work of heat alone: for all things that further the conversion, or alteration as rest, mixture of a body already concocted, &c. are also means to concoction. And there are of concoction two periods; the one assimilation, or absolute conversion and subaction; the other maturation; whereof the former is most conspicuous in the bodies of living creatures: in which there is an absolute conversion and assimilation of the nourishment into the body: and likewise in the bodies of plants: and again in metals, where there is a full transmutation. The other, which is maturation, is seen in liquors and fruits; wherein there is not desired, nor pretended, an utter conversion, but only an alteration to that form which is most sought for man's use; as in clarifying of drinks, ripening of fruits, &c. But note, that there be two kinds of absolute conversions; the one is, when a body is converted into another body, which was before; as when nourishment is turned into flesh; that is it which we call assimilation. The other is, when the conversion is into a body merely new, and which was not be-

fore; as if silver should be turned to gold, or iron to copper: and this conversion is better called, for distinction sake, transmutation.

Experiment solitary touching alterations, which may be called majors.

839. There are also divers other great alterations of matter and bodies, besides those that tend to concoction and maturation; for whatsoever doth so alter a body, as it returneth not again to that it was, may be called "alteratio major;" as when meat is boiled, or roasted, or fried, etc. or when bread and meat are baked; or when cheese is made of curds, or butter of cream, or coals of wood, or bricks of earth; and a number of others. But to apply notions philosophical to plebeian terms; or to say, where the notions cannot fitly be reconciled, that there wanteth a term or nomenclature for it, as the ancients used, they be but shifts of ignorance; for knowledge will be ever a wandering and indigested thing, if it be but a commixture of a few notions that are at hand and occur, and not excited from sufficient number of instances, and those well collated.

The consistences of bodies are very diverse: dense, rare; tangible, pneumatical; volatile, fixed; determinate, not determinate; hard, soft; cleaving, not cleaving; congelable, not congelable, liquefiable, not liquefiable; fragile, tough; flexible, inflexible; tractile, or to be drawn forth in length, intractile; porous, solid; equal and smooth, unequal; venous and fibrous, and with grains, entire; and

divers others; all which to refer to heat, and cold, and moisture, and drought, is a compendious and inutile speculation. But of these see principally our "Abecedarium naturæ;" and otherwise "sparsim" in this our "Sylva Sylvarum:" nevertheless, in some good part, we shall handle divers of them now presently.

Experiment solitary touching bodies liquefiable, and not liquefiable.

840. Liquefiable, and not liquefiable, proceed from these causes; liquefaction is ever caused by the detention of the spirits, which play within the body and open it. Therefore such bodies as are more turgid of spirit; or that have their spirits more straitly imprisoned; or, again, that hold them better pleased and content, are liquefiable: for these three dispositions of bodies do arrest the emission of the spirits. An example of the first two properties is in metals; and of the last in grease, pitch, sulphur, butter, wax, &c. The disposition not to liquefy proceedeth from the easy emission of the spirits, whereby the grosser parts contract; and therefore bodies jejune of spirits, or which part with their spirits more willingly, are not liquefiable; as wood, clay, free-stone, &c. But yet even many of those bodies that will not melt, or will hardly melt, will notwithstanding soften: as iron in the forge; and a stick bathed in hot ashes, which thereby becometh more flexible. Moreover there are some bodies which do liquefy or dissolve by fire: as metals, wax,

&c. and other bodies which dissolve in water; as salt, sugar, &c. The cause of the former proceedeth from the dilatation of the spirits by heat: the cause of the latter proceedeth from the opening of the tangible parts, which desire to receive the liquor. Again, there are some bodies that dissolve with both; as gum, etc. And those be such bodies, as on the one side have good store of spirit; and on the other side, have the tangible parts indigent of moisture; for the former helpeth to the dilating of the spirits by fire; and the latter stimulateth the parts to receive the liquor.

Experiment solitary touching bodies fragile and tough.

841. Of bodies, some are fragile: and some are tough, and not fragile; and in the breaking, some fragile bodies break but where the force is; some shatter and fly in many pieces. Of fragility, the cause is an impotency to be extended; and therefore stone is more fragile than metal; and so fictile earth is more fragile than crude earth; and dry wood than green. And the cause of this unaptness to extension, is the small quantity of spirits, for it is the spirit that furthereth the extension or dilatation of bodies, and it is ever concomitant with porosity, and with dryness in the tangible parts: contrariwise, tough bodies have more spirit, and fewer pores, and moister tangible parts: therefore we see that parchment or leather will stretch, paper will not; woollen cloth will tenter, linen scarcely.

Experiment solitary touching the two kinds of pneumaticals in bodies.

842. All solid bodies consist of parts of two several natures, pneumatical and tangible; and it is well to be noted, that the pneumatical substance is in some bodies the native spirit of the body, and in some other, plain air that is gotten in; as in bodies desiccate by heat or age: for in them when the native spirit goeth forth, and the moisture with it, the air with time getteth into the pores. And those bodies are ever the more fragile; for the native spirit is more yielding and extensive, especially to follow the parts, than air. The native spirits also admit great diversity; as hot, cold, active, dull, &c. whence proceed most of the virtues and qualities, as we call them, of bodies: but the air intermixed is without virtues, and maketh things insipid, and without any exstimulation.

Experiment solitary touching concretion and dissolution of bodies.

843. The concretion of bodies is commonly solved by the contrary; as ice, which is congealed by cold, is dissolved by heat; salt and sugar, which are excocted by heat; are dissolved by cold and moisture. The cause is, for that these operations are rather returns to their former nature, than alterations; so that the contrary cureth. As for oil, it doth neither easily congeal with cold, nor thicken with heat. The cause of both effects, though they be produced by contrary efficients, seemeth to be the

same; and that is, because the spirit of the oil by either means exhaleth little, for the cold keepeth it in: and the heat, except it be vehement, doth not call it forth. As for cold, though it take hold of the tangible parts, yet as to the spirits, it doth rather make them swell than congeal them: as when ice is congealed in a cup, ths ice will swell instead of contracting, and sometimes rift.

Experiment solitary touching hard and soft bodies.

844. Of bodies, some we see are hard, and some soft: the hardness is caused chiefly by the jejuneness of the spirits, and their imparity with the tangible parts: both which, if they be in a greater degree, make them not only hard, but fragile, and less enduring of pressure; as steel, stone, glass, dry wood, &c. Softness cometh, contrariwise, by the greater quantity of spirits, which ever helpeth to induce yielding and cession, and by the more equal spreading of the tangible parts, which thereby are more sliding and following: as in gold, lead, wax, &c. But note, that soft bodies, as we use the word, are of two kinds; the one, that easily giveth place to another body, but altereth not bulk, by rising in other places: and therefore we see that wax, if you put any thing into it, doth not rise in bulk, but only giveth place; for you may not think, that in printing of wax, the wax riseth up at all; but only the depressed part giveth place, and the other remaineth as it was. The other that altereth bulk in the cession, as water, or other liquors, if you put a stone or any thing into

them, they give place indeed easily, but then they rise all over; which is a false cession; for it is in place, and not in body.

Experiment solitary touching bodies ductile and tensile.

845. All bodies ductile and tensile, as metals, that will be drawn into wires; wool and tow, that will be drawn into yarn or thread, have in them the appetite of not discontinuing strong, which maketh them follow the force that pulleth them out; and yet so, as not to discontinue or forsake their own body. Viscous bodies likewise, as pitch, wax, birdlime, cheese toasted, will draw forth and rope. But the difference between bodies fibrous and bodies viscous is plain: for all wool, and tow, and cotton, and silk, especially raw silk, have, besides their desire of continuance, in regard of the tenuity of their thread, a greediness of moisture; and by moisture to join and incorporate with other thread; especially if there be a little wreathing; as appeareth by the twisting of thread, and the practice of twirling about of spindles. And we see also, that gold and silver thread cannot be made without twisting.

Experiment solitary touching other passions of matter, and characters of bodies.

846. The differences of impressible and not impressible; figurable and not figurable; mouldable and not mouldable; scissile and not scissile, and many other passions of matter, are plebeian notions,

applied unto the instruments and uses which men ordinarily practise; but they are all but the effects of some of these causes following, which we will enumerate without applying them, because that will be too long. The first is the cession, or not cession of bodies, into a smaller space or room, keeping the outward bulk, and not flying up. The second is the stronger or weaker appetite in bodies to continuity, and to fly discontinuity. The third is the disposition of bodies to contract, or not contract: and again, to extend, or not extend. The fourth is the small quantity, or great quantity of the pneumatical in bodies. The fifth is the nature of the pneumatical, whether it be native spirit of the body, or common air. The sixth is the nature of the native spirits in the body, whether they be active and eager, or dull and gentle. The seventh is the emission, or detention of the spirits in bodies. The eighth is the dilatation, or contraction of the spirits in bodies, while they are detained. The ninth is the collocation of the spirits in bodies, whether the collocation be equal, or unequal; and again, whether the spirits be coacervate, or diffused. The tenth is the density, or rarity of the tangible parts. The eleventh is the equality, or inequality of the tangible parts. The twelfth is the digestion, or crudity of the tangible parts. The thirteenth is the nature of the matter, whether sulphureous or mercurial, watery or oily, dry and terrestrial, or moist and liquid; which natures of sulphureous and mercurial, seem to be natures radical and principal. The fourteenth is the

placing of the tangible parts in length or transverse, as it is in the warp and the woof of textiles, more inward, or more outward, &c. The fifteenth is the porosity or imporosity betwixt the tangible parts, and the greatness or smallness of the pores. The sixteenth is the collocation and posture of the pores. There may be more causes; but these do occur for the present.

Experiment solitary touching induration by sympathy.

847. Take lead and melt it, and in the midst of it, when it beginneth to congeal, make a little dint or hole, and put quicksilver wrapped in a piece of linen into that hole, and the quicksilver will fix and run no more, and endure the hammer. This is a noble instance of induration, by consent of one body with another, and motion of excitation to imitate; for to ascribe it only to the vapour of lead, is less probable. *Query*, whether the fixing may be in such a degree, as it will be figured like other metals? For if so, you may make works of it for some purposes, so they come not near the fire.

Experiment solitary touching honey and sugar.

848. Sugar hath put down the use of honey, insomuch as we have lost those observations and preparations of honey which the ancients had, when it was more in price. First, it seemeth that there was in old time tree-honey, as well as bee-honey, which was the tear or blood issuing from the tree: insomuch as one of the ancients relateth, that in Tre-

bisond there was honey issuing from the box-trees which made men mad. Again, in ancient time there was a kind of honey, which either of its own nature, or by art, would grow as hard as sugar, and was not so luscious as ours. They had also a wine of honey, which they made thus. They crushed the honey into a great quantity of water, and then strained the liquor: after they boiled it in a copper to the half; then they poured it into earthen vessels for a small time, and after turned it into vessels of wood, and kept it for many years. They have also at this day, in Russia and those northern countries, mead simple, which, well made and seasoned, is a good wholesome drink, and very clear. They use also in Wales a compound drink of mead, with herbs and spices. But meanwhile it were good, in recompense of that we have lost in honey, there were brought in use a sugar-mead, for so we may call it, though without any mixture at all of honey, and to brew it, and keep it stale, as they use mead: for certainly, though it would not be so abstersive, and opening, and solutive a drink as mead; yet it will be more grateful to the stomach, and more lenitive, and fit to be used in sharp diseases: for we see, that the use of sugar in beer and ale hath good effects in such cases.

Experiment solitary touching the finer sort of base metals.

849. It is reported by the ancients, that there was a kind of steel in some places, which would polish almost as white and bright as silver. And that there

was in India a kind of brass, which, being polished, could scarce be discerned from gold. This was in the natural ure: but I am doubtful, whether men have sufficiently refined metals, which we count base; as whether iron, brass, and tin be refined to the height? But when they come to such a fineness, as serveth the ordinary use, they try no farther.

Experiment solitary touching cements and quarries.

850. There have been found certain cements under earth that are very soft; and yet, taken forth into the sun, harden as hard as marble: there are also ordinary quarries in Somersetshire, which in the quarry cut soft to any bigness, and in the building prove firm and hard.

Experiment solitary touching the altering of the colour of hairs and feathers.

851. Living creatures generally do change their hair with age, turning to be grey and white: as is seen in men, though some earlier, some later; in horses that are dappled, and turn white; in old squirrels that turn grisly; and many others. So do some birds; as cygnets from the grey turn white; hawks from brown turn more white. And some birds there be that upon their moulting do turn colour; as robin-red-breasts, after their moulting, grow to be red again by degrees, so do goldfinches upon the head. The cause is, for that moisture doth chiefly colour hair and feathers, and dryness turneth them grey and white: now hair in age waxeth drier; so do feathers.

As for feathers, after moulting, they are young feathers, and so all one as the feathers of young birds. So the beard is younger than the hair of the head, and doth, for the most part, wax hoary later. Out of this ground a man may devise the means of altering the colour of birds, and the retardation of hoary hairs. But of this see the fifth experiment.

Experiment solitary touching the differences of living creatures, male and female.

852. The difference between male and female, in some creatures, is not to be discerned, otherwise than in the parts of generation: as in horses and mares, dogs and bitches, doves he and she, and others. But some differ in magnitude, and that diversly; for in most the male is the greater; as in man, pheasants, peacocks, turkeys, and the like: and in some few, as in hawks, the female. Some differ in the hair and feathers, both in the quantity, crispation, and colours of them; as he-lions are hirsute, and have great manes: the shes are smooth like cats. Bulls are more crisp upon the forehead than cows; the peacock, and pheasant-cock, and goldfinch-cock, have glorious and fine colours; the hens have not. Generally the hes in birds have the fairest feathers. Some differ in divers features: as bucks have horns, does none; rams have more wreathed horns than ewes; cocks have great combs and spurs, hens little or none; boars have great fangs; sows much less; the turkey-cock hath great and swelling gills, the hen hath less: men have generally deeper and stronger voices than

women. Some differ in faculty, as the cocks amongst singing-birds are the best singers. The chief cause of all these, no doubt is, for that the males have more strength of heat than the females, which appeareth manifestly in this, that all young creatures males are like females, and so are eunuchs, and gelt creatures of all kinds, liker females. Now heat causeth greatness of growth, generally, where there is moisture enough to work upon: but if there be found in any creature, which is seen rarely, an over-great heat in proportion to the moisture, in them the female is the greater, as in hawks and sparrows. And if the heat be balanced with the moisture, then there is no difference to be seen between male and female, as in the instances of horses and dogs. We see also, that the horns of oxen and cows, for the most part, are larger than the bulls, which is caused by abundance of moisture, which in the horns of the bull faileth. Again, heat causeth pilosity and crispation, and so likewise beards in men. It also expelleth finer moisture, which want of heat cannot expel; and that is the cause of the beauty and variety of feathers. Again, heat doth put forth many excrescences, and much solid matter, which want of heat cannot do; and this is the cause of horns, and of the greatness of them, and of the greatness of the combs and spurs of cocks, gills of turkey-cocks, and fangs of boars. Heat also dilateth the pipes and organs, which causeth the deepness of the voice. Again, heat refineth the spirits, and that causeth the cock singing-bird to excel the hen.

Experiment solitary touching the comparative magnitude of living creatures.

853. There be fishes greater than any beasts; as the whale is far greater than the elephant: and beasts are generally greater than birds. For fishes, the cause may be, that because they live not in the air, they have not their moisture drawn and soaked by the air and sun-beams. Also they rest always in a manner, and are supported by the water, whereas motion and labour do consume. As for the greatness of beasts more than of birds, it is caused, for that beasts stay longer time in the womb than birds, and there nourish and grow; whereas in birds, after the egg laid, there is no further growth or nourishment from the female; for the sitting doth vivify, and not nourish.

Experiment solitary touching exossation of fruits.

854. We have partly touched before the means of producing fruits without cores or stones. And this we add farther, that the cause must be abundance of moisture; for that the core and stone are made of a dry sap: and we see, that it is possible to make a tree put forth only in blossom, without fruit, as in cherries with double flowers, much more into fruit without stone or cores. It is reported, that a cion of an apple, grafted upon a colewort stalk, sendeth forth a great apple without a core. It is not unlikely, that if the inward pith of a tree were taken out, so that the juice came only by the bark, it would work the

effect. For it hath been observed, that in pollards, if the water get in on the top, and they become hollow, they put forth the more. We add also, that it is delivered for certain by some, that if the cion be grafted the small end downwards, it will make fruit have little or no cores and stones.

Experiment solitary touching the melioration of tobacco.

855. Tobacco is a thing of great price, if it be in request: for an acre of it will be worth, as is affirmed two hundred pounds by the year towards charge. The charge of making the ground and otherwise is great, but nothing to the profit; but the English tobacco hath small credit, as being too dull and earthy: nay, the Virginian tobacco, though that be in a hotter climate, can get no credit for the same cause: so that a trial to make tobacco more aromatical, and better concocted, here in England, were a thing of great profit. Some have gone about to do it by drenching the English tobacco in a decoction or infusion of Indian tobacco; but those are but sophistications and toys; for nothing that is once perfect, and hath run his race, can receive much amendment. You must ever resort to the beginnings of things for melioration. The way of maturation of tobacco must, as in other plants, be from the heat either of the earth or of the sun: we see some leading of this in musk-melons, which are sown upon a hot-bed dunged below, upon a bank turned upon the south sun, to give heat by reflection; laid upon tiles, which

increaseth the heat, and covered with straw to keep them from cold. They remove them also, which addeth some life: and by these helps they become as good in England, as in Italy or Provence. These, and the like means, may be tried in tobacco. Inquire also of the steeping of the roots in some such liquor as may give them vigour to put forth strong.

Experiment solitary touching several heats working the same effects.

856. Heat of the sun for the maturation of fruits; yea, and the heat of vivification of living creatures, are both represented and supplied by the heat of fire; and likewise the heats of the sun, and life, are represented one by the other. Trees set upon the backs of chimneys do ripen fruit sooner. Vines, that have been drawn in at the window of a kitchen, have sent forth grapes ripe a month at least before others. Stoves at the back of walls bring forth oranges here with us. Eggs, as is reported by some, have been hatched in the warmth of an oven. It is reported by the ancients, that the ostrich layeth her eggs under sand, where the heat of the sun discloseth them.

Experiment solitary touching swelling and dilatation in boiling.

857. Barley in the boiling swelleth not much; wheat swelleth more; rice extremely, insomuch as a quarter of a pint, unboiled, will arise to a pint boiled. The cause no doubt is, for that the more close and

compact the body is, the more it will dilate: now barley is the most hollow; wheat more solid than that; and rice most solid of all. It may be also that some bodies have a kind of lentour, and more depertible nature than others; as we see it evident in coloration; for a small quantity of saffron will tinct more than a very great quantity of brasil or wine.

Experiment solitary touching the dulcoration of fruits.

858. Fruit groweth sweet by rolling, or pressing them gently with the hand; as rolling pears, damascenes, &c.: by rottenness; as medlars, services, sloes, hips, &c.: by time; as apples, wardens, pomegranates, &c.: by certain special maturations; as by laying them in hay, straw, &c.: and by fire; as in roasting, stewing, baking, &c. The cause of the sweetness by rolling and pressing, is emollition, which they properly induce; as in beating of stock-fish, flesh, &c.: by rottenness is, for that the spirits of the fruit by putrefaction gather heat, and thereby digest the harder part, for in all putrefactions there is a degree of heat: by time and keeping is, because the spirits of the body do ever feed upon the tangible parts, and attenuate them: by several maturations is, by some degree of heat: and by fire is, because it is the proper work of heat to refine, and to incorporate; and all sourness consisteth in some grossness of the body; and all incorporation doth make the mixture of the body more equal in all the parts; which ever induceth a milder taste.

Experiment solitary touching flesh edible, and not edible.

859. Of fleshes, some are edible; some, except it be in famine, not. For those that are not edible, the cause is, for that they have commonly too much bitterness of taste; and therefore those creatures which are fierce and choleric are not edible; as lions, wolves, squirrels, dogs, foxes, horses, &c. As for kine, sheep, goats, deer, swine, conies, hares, &c. we see they are mild and fearful. Yet it is true, that horses, which are beasts of courage, have been, and are eaten by some nations; as the Scythians were called Hippophagi; and the Chinese eat horse-flesh at this day; and some gluttons have used to have colts'-flesh baked. In birds, such as are carnivoræ, and birds of prey, are commonly no good meat, but the reason is, rather the choleric nature of those birds, than their feeding upon flesh: for pewets, gulls, shovellers, ducks, do feed upon flesh, and yet are good meat. And we see that those birds which are of prey, or feed upon flesh, are good meat when they are very young; as hawks, rooks out of the nest, owls, &c. Man's flesh is not eaten. The reasons are three: first, because men in humanity do abhor it: secondly, because no living creature that dieth of itself is good to eat: and therefore the cannibals themselves eat no man's flesh of those that die of themselves, but of such as are slain. The third is, because there must be generally some disparity between the nourishment and the body nourished; and they must not be over-near, or like: yet we see, that in great weak-

nesses and consumptions, men have been sustained with woman's milk; and Facinus, fondly, as I conceive, adviseth, for the prolongation of life, that a vein be opened in the arm of some wholesome young man, and the blood to be sucked. It is said that witches do greedily eat man's flesh; which if it be true, besides a devilish appetite in them, it is likely to proceed, for that man's flesh may send up high and pleasing vapours, which may stir the imagination; and witches' felicity is chiefly in imagination, as hath been said.

Experiment solitary touching the salamander.

860. There is an ancient received tradition of the salamander, that it liveth in the fire, and hath force also to extinguish the fire. It must have two things, if it be true, to this operation: the one a very close skin, whereby flame, which in the midst is not so hot, cannot enter; for we see that if the palm of the hand be anointed thick with white of egg, and then aqua vitæ be poured upon it, and inflamed, yet one may endure the flame a pretty while. The other is some extreme cold and quenching virtue in the body of that creature, which choketh the fire. We see that milk quencheth wild-fire better than water, because it entereth better.

Experiment solitary touching the contrary operations of time upon fruits and liquors.

861. Time doth change fruit, as apples, pears, pomegranates, &c. from more sour to more sweet: but

contrariwise liquors, even those that are of the juice of fruit, from more sweet to more sour: as wort, musted, new verjuice, &c. The cause is, the congregation of the spirits together: for in both kinds the spirit is attenuated by time; but in the first kind it is more diffused, and more mastered by the grosser parts, which the spirits do but digest: but in drinks the spirits do reign, and finding less opposition of the parts, become themselves more strong; which causeth also more strength in the liquor; such as if the spirits be of the hotter sort, the liquor becometh apt to burn: but in time, it causeth likewise, when the higher spirits are evaporated, more sourness.

Experiment solitary touching blows and bruises.

862. It hath been observed by the ancients, that plates of metal, and especially of brass, applied presently to a blow, will keep it down from swelling. The cause is repercussion, without humectation or entrance of any body: for the plate hath only a virtual cold, which doth not search into the hurt; whereas all plaisters and ointments do enter. Surely, the cause that blows and bruises induce swellings is, for that the spirits resorting to succour the part that laboureth, draw also the humours with them: for we see, that it is not the repulse and the return of the humour in the part strucken that causeth it; for that gouts and tooth-aches cause swelling, where there is no percussion at all.

Experiment solitary touching the orrice root.

863. The nature of the orrice root is almost singular; for there be few odoriferous roots; and in those that are in any degree sweet, it is but the same sweetness with the wood or leaf: but the orrice is not sweet in the leaf; neither is the flower any thing so sweet as the root. The root seemeth to have a tender dainty heat; which when it cometh above ground to the sun and the air, vanisheth: for it is a great mollifier; and hath a smell like a violet.

Experiment solitary touching the compression of liquors.

864. It hath been observed by the ancients, that a great vessel full, drawn into bottles, and then the liquor put again into the vessel, will not fill the vessel again so full as it was, but that it may take in more liquor: and that this holdeth more in wine than in water. The cause may be trivial; namely, by the expence of the liquor, in regard some may stick to the sides of the bottles: but there may be a cause more subtile; which is, that the liquor in the vessel is not so much compressed as in the bottle; because in the vessel the liquor meeteth with liquor chiefly; but in the bottles a small quantity of liquor meeteth with the sides of the bottles, which compress it so that it doth not open again.

Experiment solitary touching the working of water upon air contiguous.

865. Water, being contiguous with air, cooleth it, but moisteneth it not, except it vapour. The cause is, for that heat and cold have a virtual transition, without communication of substance; but moisture not: and to all madefaction there is required an imbibition: but where the bodies are of such several levity and gravity as they mingle not, there can follow no imbibition. And therefore, oil likewise lieth at the top of the water, without commixture: and a drop of water running swiftly over a straw or smooth body, wetteth not.

Experiment solitary touching the nature of air.

866. Star-light nights, yea, and bright moonshine nights, are colder than cloudy nights. The cause is, the dryness and fineness of the air, which thereby becometh more piercing and sharp; and therefore great continents are colder than islands: and as for the moon, though itself inclineth the air to moisture, yet when it shineth bright, it argueth the air is dry. Also close air is warmer than open air; which, it may be, is, for that the true cause of cold is an expiration from the globe of the earth, which in open places is stronger; and again, air itself, if it be not altered by that expiration, is not without some secret degree of heat; as it is not likewise without some secret degree of light: for otherwise cats and owls could not see in the night; but that

air hath a little light, proportionable to the visual spirits of those creatures.

Experiments in consort touching the eyes and sight.

867. The eyes do move one and the same way; for when one eye moveth to the nostril, the other moveth from the nostril. The cause is motion of consent, which in the spirits and parts spiritual is strong. But yet use will induce the contrary; for some can squint when they will: and the common tradition is, that if children be set upon a table with a candle behind them, both eyes will move outwards, as affecting to see the light, and so induce squinting.

868. We see more exquisitely with one eye shut, than with both open. The cause is, for that the spirits visual unite themselves more, and so become stronger. For you may see, by looking in a glass, that when you shut one eye, the pupil of the other eye that is open dilateth.

869. The eyes, if the sight meet not in one angle, see things double. The cause is, for that seeing two things, and seeing one thing twice, worketh the same effect: and therefore a little pellet held between two fingers laid across, seemeth double.

870. Pore-blind men see best in the dimmer lights: and likewise have their sight stronger near hand, than those that are not pore-blind; and can read and write smaller letters. The cause is, for that the spirits visual in those that are pore-blind, are thinner and rarer than in others; and therefore

the greater light disperseth them. For the same cause they need contracting; but being contracted, are more strong than the visual spirits of ordinary eyes are; as when we see through a level, the sight is the stronger; and so is it when you gather the eye-lids somewhat close: and it is commonly seen in those that are pore-blind, that they do much gather the eye-lids together. But old men, when they would see to read, put the paper somewhat afar off: the cause is, for that old men's spirits visual, contrary to those of pore-blind men, unite not, but when the object is at some good distance from their eyes.

871. Men see better, when their eyes are over-against the sun or a candle, if they put their hand a little before their eyes. The reason is, for that the glaring of the sun or the candle doth weaken the eye; whereas the light circumfused is enough for the perception. For we see that an over-light maketh the eyes dazzle; insomuch as perpetual looking against the sun would cause blindness. Again, if men come out of a great light into a dark room; and contrariwise, if they come out of a dark room into a light room, they seem to have a mist before their eyes, and see worse than they shall do after they have stayed a little while, either in the light or in the dark. The cause is, for that the spirits visual are, upon a sudden change, disturbed and put out of order; and till they be recollected, do not perform their function well. For when they are much dilated by light, they cannot

contract suddenly; and when they are much contracted by darkness, they cannot dilate suddenly. And excess of both these, that is, of the dilatation and contraction of the spirits visual, if it be long destroyeth the eye. For as long looking against the sun or fire hurteth the eye by dilatation; so curious painting in small volumes, and reading of small letters, do hurt the eye by contraction.

872. It hath been observed, that in anger the eyes wax red; and in blushing, not the eyes, but the ears, and the parts behind them. The cause is, for that in anger the spirits ascend and wax eager; which is most easily seen in the eyes, because they are translucid; though withal it maketh both the cheeks and the gills red; but in blushing, it is true the spirits ascend likewise to succour both the eyes and the face, which are the parts that labour; but then they are repulsed by the eyes, for that the eyes, in shame, do put back the spirits that ascend to them, as unwilling to look abroad: for no man in that passion doth look strongly, but dejectedly; and that repulsion from the eyes diverteth the spirits and heat more to the ears, and the parts by them.

873. The objects of the sight may cause a great pleasure and delight in the spirits, but no pain or great offence; except it be by memory, as hath been said. The glimpses and beams of diamonds that strike the eye; Indian feathers, that have glorious colours; the coming into a fair garden; the coming into a fair room richly furnished; a beautiful

person; and the like; do delight and exhilarate the spirits much. The reason why it holdeth not in the offence is, for that the sight is the most spiritual of the senses; whereby it hath no object gross enough to offend it. But the cause chiefly is, for that there be no active objects to offend the eye. For harmonical sounds, and discordant sounds, are both active and positive: so are sweet smells and stinks: so are bitter and sweet in tastes: so are over-hot and over-cold in touch: but blackness and darkness are indeed but privatives; and therefore have little or no activity. Somewhat they do contristate, but very little.

Experiment solitary touching the colour of the sea or other water.

874. Water of the sea, or otherwise, looketh blacker when it is moved, and whiter when it resteth. The cause is, for that by means of the motion, the beams of light pass not straight, and therefore must be darkened: whereas, when it resteth, the beams do pass straight. Besides, splendour hath a degree of whiteness; especially if there be a little repercussion: for a looking-glass with the steel behind, looketh whiter than glass simple. This experiment deserveth to be driven farther, in trying by what means motion may hinder sight.

Experiment solitary touching shell-fish.

875. Shell-fish have been, by some of the ancients, compared and sorted with the insecta; but I see no

reason why they should; for they have male and female as other fish have: neither are they bred of putrefaction; especially such as do move. Nevertheless it is certain, that oisters, and cockles, and mussels, which move not, have no discriminate sex. Query, in what time, and how they are bred? It seemeth, that shells of oisters are bred where none were before; and it is tried, that the great horse-mussel, with the fine shell, that breedeth in ponds, hath bred within thirty years: but then, which is strange, it hath been tried, that they do not only gape and shut as the oisters do, but remove from one place to another.

Experiment solitary touching the right side and the left.

876. The senses are alike strong, both on the right side and on the left; but the limbs on the right side are stronger. The cause may be, for that the brain, which is the instrument of sense, is alike on both sides; but motion, and abilities of moving, are somewhat holpen from the liver, which lieth on the right side. It may be also, for that the senses are put in exercise indifferently on both sides from the time of our birth; but the limbs are used most on the right side, whereby custom helpeth; for we see that some are left-handed; which are such as have used the left hand most.

Experiment solitary touching frictions.

877. Frictions make the parts more fleshy and

full; as we see both in men, and in currying of horses, &c. The cause is, for that they draw greater quantity of spirits and blood to the parts: and again, because they draw the aliment more forcibly from within: and again, because they relax the pores, and so make better passage for the spirits, blood, and aliment: lastly, because they dissipate and digest any inutile or excrementitious moisture which lieth in the flesh; all which help assimilation. Frictions also do more fill and impinguate the body, than exercise. The cause is, for that in frictions the inward parts are at rest; which in exercise are beaten, many times, too much: and for the same reason, as we have noted heretofore, galley-slaves are fat and fleshy, because they stir the limbs more, and the inward parts less.

Experiment solitary touching globes appearing flat at distance.

878. All globes afar off appear flat. The cause is, for that distance, being a secondary object of sight, is not otherwise discerned, than by more or less light; which disparity, when it cannot be discerned, all seemeth one: as it is, generally, in objects not distinctly discerned; for so letters, if they be so far off as they cannot be discerned, shew but as a duskish paper; and all engravings and embossings, afar off, appear plain.

Experiment solitary touching shadows.

879. The uttermost parts of shadows seem ever

to tremble. The cause is, for that the little motes which we see in the sun do ever stir, though there be no wind; and therefore those moving, in the meeting of the light and the shadow, from the light to the shadow, and from the shadow to the light, do shew the shadow to move, because the medium moveth.

Experiment solitary touching the rolling and breaking of the seas.

880. Shallow and narrow seas break more than deep and large. The cause is, for that, the impulsion being the same in both, where there is greater quantity of water, and likewise space enough, there the water rolleth and moveth, both more slowly, and with a sloper rise and fall: but where there is less water, and less space, and the water dasheth more against the bottom, there it moveth more swiftly, and more in precipice; for in the breaking of the waves there is ever a precipice.

Experiment solitary touching the dulcoration of salt water.

881. It hath been observed by the ancients, that salt water boiled, or boiled and cooled again, is more potable, than of itself raw: and yet the taste of salt in distillations by fire riseth not, for the distilled water will be fresh. The cause may be, for that the salt part of the water doth partly rise into a kind of scum on the top, and partly goeth into a sediment in the bottom, and so is rather a separation than an

evaporation. But it is too gross to rise into a vapour, and so is a bitter taste likewise; for simple distilled waters, of wormwood, and the like, are not bitter.

Experiment solitary touching the return of saltness in pits upon the sea-shore.

882. It hath been set down before, that pits upon the sea-shore turn into fresh water, by percolation of the salt through the sand: but it is further noted, by some of the ancients, that in some places of Africa, after a time, the water in such pits will become brackish again. The cause is, for that after a time, the very sands through which the salt water passeth, become salt, and so the strainer itself is tinctured with salt. The remedy therefore is, to dig still new pits, when the old wax brackish; as if you would change your strainer.

Experiment solitary touching attraction by similitude of substance.

883. It hath been observed by the ancients, that salt water will dissolve salt put into it, in less time than fresh water will dissolve it. The cause may be, for that the salt in the precedent water doth, by similitude of substance, draw the salt new put in unto it; whereby it diffuseth in the liquor more speedily. This is a noble experiment, if it be true, for it sheweth means of more quick and easy infusions, and it is likewise a good instance of attraction by similitude of substance. Try it with sugar put into water formerly sugared, and into other water unsugared.

Experiment solitary touching attraction.

884. Put sugar into wine, part of it above, part under the wine, and you shall find, that which may seem strange, that the sugar above the wine will soften and dissolve sooner than that within the wine. The cause is, for that the wine entereth that part of the sugar which is under the wine, by simple infusion or spreading; but that part above the wine is likewise forced by sucking; for all spongy bodies expel the air and draw in liquor, if it be contiguous: as we see it also in sponges put part above the water. It is worthy the inquiry, to see how you may make more accurate infusions, by help of attraction.

Experiment solitary touching heat under earth.

885. Water in wells is warmer in winter than in summer; and so air in caves. The cause is, for that in the higher parts, under the earth, there is a degree of some heat, as appeareth in sulphureous veins, &c. which shut close in, as in winter, is the more; but if it perspire, as it doth in summer, it is the less.

Experiment solitary touching flying in the air.

886. It is reported, that amongst the Leucadians, in ancient time, upon a superstition they did use to precipitate a man from a high cliff into the sea, tying about him with strings, at some distance, many great fowls, and fixing unto his body divers feathers, spread, to break the fall. Certainly many birds of

good wing, as kites, and the like, would bear up a good weight as they fly, and spreading of feathers thin and close, and in great breadth, will likewise, bear up a great weight, being even laid, without tilting upon the sides. The farther extension of this experiment for flying may be thought upon.

Experiment solitary touching the dye of scarlet.

887. There is in some places, namely in Cephalonia, a little shrub which they call holly-oak, or dwarf-oak: upon the leaves whereof there riseth a tumour like a blister; which they gather, and rub out of it a certain red dust, that converteth, after a while, into worms, which they kill with wine, as is reported, when they begin to quicken: with this dust they dye scarlet.

Experiment solitary touching maleficiating.

888. In Zant it is very ordinary to make men impotent to accompany with their wives. The like is practised in Gascony; where it is called nouër l'eguillette. It is practised always upon the wedding-day. And in Zant the mothers themselves do it, by way of prevention; because thereby they hinder other charms, and can undo their own. It is a thing the civil law taketh knowledge of; and therefore is of no light regard.

Experiment solitary touching the rise of water by means of flame.

889. It is a common experiment, but the cause

is mistaken. Take a pot, or better a glass, because therein you may see the motion, and set a candle lighted in the bottom of a bason of water, and turn the mouth of the pot or glass over the candle, and it will make the water rise. The ascribe it to the drawing of heat; which is not true: for it appeareth plainly to be but a motion of nexe, which they call ne detur vacuum; and it proceedeth thus. The flame of the candle, as soon as it is covered, being suffocated by the close air, lesseneth by little and little; during which time there is some little ascent of water, but not much: for the flame occupying less and less room, as it lesseneth, the water succeedeth. But upon the instant of the candle's going out, there is a sudden rise of a great deal of water; for that the body of the flame filleth no more place, and so the air and the water succeed. It worketh the same effect, if instead of water you put flour or sand into the bason: which sheweth, that it is not the flame's drawing the liquor as nourishment, as it is supposed; for all bodies are alike unto it, as it is ever in motion of nexe; insomuch as I have seen the glass, being held by the hand, hath lifted up the bason and all; the motion of nexe did so clasp the bottom of the bason. That experiment, when the bason was lifted up, was made with oil, and not with water: nevertheless this is true, that at the very first setting of the mouth of the glass upon the bottom of the bason, it draweth up the water a little, and then standeth at a stay, almost till the candle's going

out, as was said. This may shew some attraction at first: but of this we will speak more, when we handle attractions by heat.

Experiments in consort touching the influences of the moon.

Of the power of the celestial bodies, and what more secret influences they have, besides the two manifest influences of heat and light, we shall speak when we handle experiments touching the celestial bodies: mean while we will give some directions for more certain trials of the virtue and influences of the moon, which is our nearest neighbour.

The influences of the moon, most observed, are four; the drawing forth of heat: the inducing of putrefaction; the increase of moisture; the exciting of the motions of spirits.

890. For the drawing forth of heat, we have formerly prescribed to take water warm, and to set part of it against the moon-beams, and part of it with a screen between; and to see whether that which standeth exposed to the beams will not cool sooner. But because this is but a small interposition, though in the sun we see a small shade doth much, it were good to try it when the moon shineth, and when the moon shineth not at all; and with water warm in a glass bottle, as well as in a dish; and with cinders; and with iron red-hot, &c.

891. For the inducing of putrefaction, it were good to try it with flesh or fish exposed to the moon-beams; and again exposed to the air when the moon

shineth not, for the like time: to see whether will corrupt sooner: and try it also with capon, or some other fowl, laid abroad, to see whether it will mortify and become tender sooner; try it also with dead flies, or dead worms, having a little water cast upon them, to see whether will putrify sooner. Try it also with an apple or orange, having holes made in their tops, to see whether will rot or mould sooner. Try it also with Holland cheese, having wine put into it, whether will breed mites sooner or greater.

892. For the increase of moisture, the opinion received is; that seeds will grow soonest; and hair, and nails, and hedges, and herbs cut, &c. will grow soonest, if they be set or cut in the increase of the moon. Also that brains in rabbits, woodcocks, calves, &c. are fullest in the full of the moon: and so of marrow in the bones; and so of oisters and cockles, which of all the rest are the easiest tried if you have them in pits.

893. Take some seeds, or roots, as onions, &c. and set some of them immediately after the change; and others of the same kind immediately after the full: let them be as like as can be; the earth also the same as near as may be; and therefore best in pots. Let the pots also stand where no rain or sun may come to them, lest the difference of the weather confound the experiment: and then see in what time the seeds set in the increase of the moon come to a certain height; and how they differ from those that are set in the decrease of the moon.

894. It is like, that the brain of man waxeth moister and fuller upon the full of the moon: and therefore it were good for those that have moist brains, and are great drinkers, to take fume of lignum aloës rosemary, frankincense, &c. about the full of the moon. It is like also, that the humours in men's bodies increase and decrease as the moon doth: and therefore it were good to purge some day or two after the full; for that then the humours will not replenish so soon again.

895. As for the exciting of the motion of the spirits, you must note that the growth of hedges, herbs, hair, &c. is caused from the moon, by exciting of the spirits, as well as by increase of the moisture. But for spirits in particular, the great instance is in lunacies.

896. There may be other secret effects of the influence of the moon, which are not yet brought into observation. It may be, that if it so fall out that the wind be north, or north-east, in the full of the moon, it increaseth cold; and if south, or south-west, it disposeth the air for a good while to warmth and rain; which would be observed.

897. It may be, that children, and young cattle, that are brought forth in the full of the moon, are stronger and larger than those that are brought forth in the wane; and those also which are begotten in the full of the moon: so that it might be good husbandry to put rams and bulls to their females, somewhat before the full of the moon. It may be also, that the eggs laid in the full

of the moon breed the better birds; and a number of the like effects which may be brought into observation. *Query* also, whether great thunders and earthquakes be not most in the full of the moon.

Experiment solitary touching vinegar.

898. The turning of wine to vinegar is a kind of putrefaction: and in making of vinegar, they use to set vessels of wine over-against the noon sun; which calleth out the more oily spirits, and leaveth the liquor more sour and hard. We also see, that burnt wine is more hard and astringent than wine unburnt. It is said, that cider in navigations under the line ripeneth, when wine or beer soureth. It were good to set a rundlet of verjuice over-against the sun in summer, as they do vinegar, to see whether it will ripen and sweeten.

Experiment solitary touching creatures that sleep all winter.

899. There be divers creatures that sleep all winter, as the bear, the hedge-hog, the bat, the bee, &c. These all wax fat when they sleep, and egest not. The cause of their fattening during their sleeping time, may be the want of assimilating; for whatsoever assimilateth not to flesh turneth either to sweat or fat. These creatures, for part of their sleeping time, have been observed not to stir at all; and for the other part, to stir, but not to remove. And they get warm and close places to sleep in. When the Flemings wintered in Nova Zembla, the

bears about the middle of November went to sleep; and then the foxes began to come forth, which durst not before. It is noted by some of the ancients, that the she-bear breedeth, and lieth in with her young, during that time of rest; and that a bear big with young hath seldom been seen.

Experiment solitary touching the generating of creatures by copulation and putrefaction.

900. Some living creatures are procreated by copulation between male and female. some by putrefaction: and of those which come by putrefaction, many do nevertheless, afterwards procreate by copulation. For the cause of both generations: first, it is most certain, that the cause of all vivification is a gentle and proportionable heat, working upon a glutinous and yielding substance: for the heat doth bring forth spirit in that substance: and the substance being glutinous produceth two effects; the one, that the spirit is detained, and cannot break forth: the other, that the matter beiug gentle and yielding, is driven forwards by the motion of the spirits, after some swelling, into shape and members. Therefore all sperm, all menstruous substance, all matter whereof creatures are produced by putrefaction, have evermore a closeness, lentor, and sequacity. It seemeth therefore, that the generation by sperm only, and by putrefaction, have two different causes. The first is, for that creatures which have a definite and exact shape, as those have which are procreated by copulation, cannot be

produced by a weak and casual heat; nor out of matter which is not exactly prepared according to the species. The second is, for that there is a greater time required for maturation of perfect creatures; for if the time required in vivification be of any length, then the spirit will exhale before the creature be mature; except it be inclosed in a place where it may have continuance of the heat, access of some nourishment to maintain it, and closeness that may keep it from exhaling: and such places are the wombs and matrices of the females. And therefore all creatures made of putrefaction are of more uncertain shape; and are made in shorter time; and need not so perfect an inclosure, though some closeness be commonly required. As for the Heathen opinion, which was, that upon great mutations of the world, perfect creatures were first engendered of concretion; as well as frogs, and worms, and flies, and such like, are now; we know it to be vain: but if any such thing should be admitted, discoursing according to sense, it cannot be, except you admit a chaos first, and commixture of heaven and earth. For the frame of the world, once in order, cannot affect it by any excess or casualty.

NATURAL HISTORY.

CENTURY X.

Experiments in consort touching the transmission and influx of immateriate virtues, and the force of imagination.

THE philosophy of Pythagoras, which was full of superstition, did first plant a monstrous imagination, which afterwards was, by the school of Plato and others, watered and nourished. It was, that the world was one entire perfect living creature; insomuch as Apollonius of Tyana, a Pythagorean prophet, affirmed, that the ebbing and flowing of the sea was the respiration of the world, drawing in water as breath, and putting it forth again. They went on, and inferred, that if the world were a living creature, it had a soul and spirit; which also they held, calling it spiritus mundi, the spirit or soul of the world: by which they did not intend God, for they did admit of a Deity besides, but only the soul or essential form of the universe. This foundation being laid, they might build upon it what they would; for in a living creature, though never so great, as for example, in a great whale, the sense and the effects of any one part of the body

instantly make a transcursion throughout the whole body: so that by this they did insinuate, that no distance of place, nor want of indisposition of matter, could hinder magical operations; but that, for example, we might here in Europe have sense and feeling of that which was done in China; and likewise we might work any effect without and against matter; and this not holpen by the co-operation of angels or spirits, but only by the unity and harmony of nature. There were some also that stayed not here; but went farther, and held, that if the spirit of man, whom they call the microcosm, do give a fit touch to the spirit of the world, by strong imaginations and beliefs, it might command nature; for Paracelsus, and some darksome authors of magic, do ascribe to imagination exalted, the power of miracle-working faith. With these vast and bottomless follies men have been in part entertained.

But we, that hold firm to the works of God, and to the sense, which is God's lamp, lucerna Dei spiraculum hominis, will inquire with all sobriety and severity, whether there be to be found in the footsteps of nature, any such transmission and influx of immateriate virtues; and what the force of imagination is; either upon the body imaginant, or upon another body: wherein it will be like that labour of Hercules, in purging the stable of Augeas, to separate from superstitious and magical arts and observations, any thing that is clean and pure natural; and not to be either contemned or condemned. And although we shall have occasion to speak of this in more places

than one, yet we will now make some entrance thereinto.

Experiments in consort, monitory, touching transmission of spirits, and the force of imagination.

901. Men are to be admonished that they do not withdraw credit from the operations by transmission of spirits, and force of imagination, because the effects fail sometimes. For as in infection, and contagion from body to body, as the plague, and the like, it is most certain that the infection is received, many times, by the body passive, but yet is, by the strength and good disposition thereof, repulsed and wrought out, before it be formed into a disease; so much more in impressions from mind to mind, or from spirit to spirit, the impression taketh, but is encountered and overcome by the mind and spirit, which is passive, before it work any manifest effect. And therefore they work most upon weak minds and spirits; as those of women, sick persons, superstitious and fearful persons, children, and young creatures:

"Nescio quis teneros oculus mihi fascinat agnos:"

The poet speaketh not of sheep, but of lambs. As for the weakness of the power of them upon kings and magistrates, it may be ascribed, besides the main, which is the protection of God over those that execute his place, to the weakness of the imagination of the imaginant: for it is hard for a witch or a sorcerer to put on a belief that they can hurt such persons.

902. Men are to be admonished, on the other side, that they do not easily give place and credit to these operations, because they succeed many times; for the cause of this success is oft to be truly ascribed unto the force of affection and imagination upon the body agent; and then by a secondary means it may work upon a diverse body: as for example, if a man carry a planet's seal, or a ring, or some part of a beast, believing strongly that it will help him to obtain his love; or to keep him from danger of hurt in fight; or to prevail in a suit, &c. it may make him more active and industrious: and again, more confident and persisting, than otherwise he would be. Now the great effects that may come of industry and perseverance, especially in civil business, who knoweth not? For we see audacity doth almost bind and mate the weaker sort of minds; and the state of human actions is so variable, that to try things oft, and never to give over, doth wonders: therefore it were a mere fallacy and mistaking to ascribe that to the force of imagination upon another body which is but the force of imagination upon the proper body; for there is no doubt but that imagination and vehement affection work greatly upon the body of the imaginant; as we shall shew in due place.

903. Men are to be admonished, that as they are not to mistake the causes of these operations; so much less they are to mistake the fact or effect; and rashly to take that for done which is not done. And therefore, as divers wise judges have prescribed and

cautioned, men may not too rashly believe the confessions of witches, nor yet the evidence against them. For the witches themselves are imaginative, and believe oft-times they do that which they do not: and people are credulous in that point, and ready to impute accidents and natural operations to witchcraft. It is worthy the observing, that both in ancient and late times, as in the Thessalian witches, and the meetings of witches that have been recorded by so many late confessions, the great wonders which they tell, of carrying in the air, transforming themselves into other bodies, &c. are still reported to be wrought, not by incantations or ceremonies, but by ointments, and anointing themselves all over. This may justly move a man to think that these fables are the effects of imagination: for it is certain that ointments do all, if they be laid on any thing thick, by stopping of the pores, shut in the vapours, and send them to the head extremely. And for the particular ingredients of those magical ointments, it is like they are opiate and soporiferous. For anointing of the forehead, neck, feet, back-bone, we know, is used for procuring dead sleeps: and if any man say that this effect would be better done by inward potions; answer may be made, that the medicines which go to the ointments are so strong, that if they were used inwards, they would kill those that use them: and therefore they work potently, though outwards.

We will divide the several kinds of the operations by transmission of spirits and imaginations, which will give no small light to the experiments that

follow. All operations by transmission of spirits and imagination, have this; that they work at distance, and not at touch; and they are these being distinguished.

904. The first is the transmission or emission of the thinner and more airy parts of bodies; as in odours and infections; and this is, of all the rest, the most corporeal. But you must remember withal, that there be a number of those emissions, both wholesome and unwholesome, that give no smell at all: for the plague, many times when it is taken, giveth no scent at all: and there be many good and healthful airs that do appear by habitation and other proofs, that differ not in smell from other airs. And under this head you may place all imbibitions of air, where the substance is material, odour-like, whereof some nevertheless are strange, and very suddenly diffused; as the alteration which the air receiveth in Egypt, almost immediately, upon the rising of the river of Nilus, whereof we have spoken.

905. The second is the transmission or emission of those things that we call spiritual species: as visibles and sounds; the one whereof we have handled, and the other we shall handle in due place. These move swiftly, and at great distance; but then they require a medium well disposed, and their transmission is easily stopped.

906. The third is the emissions, which cause attraction of certain bodies at distance, wherein though the loadstone be commonly placed in the first rank, yet we think good to except it, and refer it to

another head: but the drawing of amber and jet, and other electric bodies, and the attraction in gold of the spirit of quicksilver at distance; and the attraction of heat at distance; and that of fire to naphtha; and that of some herbs to water, though at distance; and divers others; we shall handle, but yet not under this present title, but under the title of attraction in general.

907. The fourth is the emission of spirts, and immateriate powers and virtues, in those things which work by the universal configuration and sympathy of the world; not by forms, or celestial influxes, as is vainly taught and received, but by the primitive nature of matter, and the seeds of things. Of this kind is, as we yet suppose, the working of the loadstone, which is by consent with the globe of the earth: of this kind is the motion of gravity, which is by consent of dense bodies with the globe of the earth: of this kind is some disposition of bodies to rotation, and particularly from east to west: of which kind we conceive the main float and refloat of the sea is, which is by consent of the universe, as part of the diurnal motion. These immateriate virtues have this property differing from others; that the diversity of the medium hindereth them not; but they pass through all mediums, yet at determinate distances. And of these we shall speak, as they are incident to several titles.

908. The fifth is the emission of spirits; and this is the principal in our intention to handle now in this place; namely, the operation of the spirits of the

mind of man upon other spirits: and this is of a double nature, the operations of the affections, if they be vehement, and the operation of the imagination, if it be strong. But these two are so coupled, as we shall handle them together: for when an envious or amorous aspect doth infect the spirits of another, there is joined both affection and imagination.

909. The sixth is, the influxes of the heavenly bodies, besides these two manifest ones, of heat and light. But these we will handle where we handle the celestial bodies and motions.

910. The seventh is the operations of sympathy, which the writers of natural magic have brought into an art or precept: and it is this; that if you desire to super-induce any virtue or disposition upon a person, you should take the living creature, in which that virtue is most eminent, and in perfection; of that creature you must take the parts wherein that virtue chiefly is collocate: again, you must take those parts in the time and act when that virtue is most in exercise; and then you must apply it to that part of man wherein that virtue chiefly consisteth. As if you would super-induce courage and fortitude, take a lion or a cock; and take the heart, tooth, or paw of the lion; or the heart or spur of the cock: take those parts immediately after the lion or the cock have been in fight, and let them be worn upon a man's heart or wrist. Of these, and such like sympathies, we shall speak under this present title.

911. The eighth and last is, an emission of immateriate virtues, such as we are a little doubtful to pro-

pound, it is so prodigious; but that it is so constantly avouched by many: and we have set it down as a law to ourselves, to examine things to the bottom; and not to receive upon credit, or reject upon improbabilities, until there hath passed a due examination. This is the sympathy of individuals; for as there is a sympathy of species, so it may be there is a sympathy of individuals: that is, that in things, or the parts of things that have been once contiguous or entire, there should remain a transmission of virtue from the one to the other: as between the weapon and the wound. Whereupon is blazed abroad the operation of unguentem teli: and so of a piece of lard, or stick of elder, &c. that if part of it be consumed or putrefied, it will work upon the other part severed. Now we will pursue the instances themselves.

Experiments in consort touching emission of spirits in vapour or exhalation, odour-like.

912. The plague is many times taken without manifest sense, as hath been said. And they report, that where it is found, it hath a scent of the smell of a mellow apple; and, as some say, of May-flowers: and it is also received, that smells of flowers that are mellow and luscious, are ill for the plague, as white lilies, cowslips, and hyacinths.

913. The plague is not easily received by such as continually are about them that have the plague; as keepers of the sick, and physicians: nor again by such as take antidotes, either inward, as mithridate, juniper-berries, rue, leaf and seed, &c. or outward, as angelica, zedoary, and the like, in the mouth; tar,

galbanum, and the like, in perfume; nor again by old people, and such as are of a dry and cold complexion. On the other side, the plague taketh soonest hold of those that come out of a fresh air, and of those that are fasting, and of children; and it is likewise noted to go in a blood, more than to a stranger.

914. The most pernicious infection, next the plague, is the smell of the jail, when prisoners have been long, and close, and nastily kept; whereof we have had in our time experience twice or thrice; when both the judges that sat upon the jail, and numbers of those that attended the business or were present, sickened upon it, and died. Therefore it were good wisdom, that in such cases the jail were aired before they be brought forth.

915. Out of question, if such foul smells be made by art, and by the hand, they consist chiefly of man's flesh or sweat putrified; for they are not those stinks which the nostrils straight abhor and expel, that are most pernicious; but such airs as have some similitude with man's body: and so insinuate themselves, and betray the spirits. There may be great danger in using such compositions, in great meetings of people within houses; as in churches, at arraignments, at plays and solemnities, and the like: for poisoning of air is no less dangerous than poisoning of water, which hath been used by the Turks in the wars, and was used by Emmanuel Comnenus towards the Christians, when they passed through his country to the Holy Land. And these impoisonments of air are the more dangerous in meetings of

people, because the much breath of people doth further the reception of the infection; and therefore, where any such thing is feared, it were good those public places were perfumed, before the assemblies.

916. The impoisonment of particular persons by odours, hath been reported to be in perfumed gloves, or the like: and it is like, they mingle the poison that is deadly, with some smells that are sweet, which also maketh it the sooner received. Plagues also have been raised by anointings of the chinks of doors, and the like; not so much by the touch, as for that it is common for men, when they find any thing wet upon their fingers, to put them to their nose; which men therefore should take heed how they do. The best is, that these compositions of infectious airs cannot be made without danger of death to them that make them. But then again, they may have some antidotes to save themselves; so that men ought not to be secure of it.

917. There have been in divers countries great plagues, by the putrefaction of great swarms of grasshoppers and locusts, when they have been dead and cast upon heaps.

918. It happeneth often in mines, that there are damps which kill, either by suffocation, or by the poisonous nature of the mineral: and those that deal much in refining, or other works about metals and minerals, have their brains hurt and stupified by the metalline vapours. Amongst which it is noted, that the spirits of quicksilver either fly to the skull, teeth, or bones; insomuch as gilders use to have a piece of

gold in their mouth, to draw the spirits of the quicksilver; which gold afterwards they find to be whitened. There are also certain lakes and pits, such as that of Avernus, that poison birds, as is said, which fly over them, or men that stay too long about them.

919. The vapour of charcoal, or sea-coal, in a close room, hath killed many; and it is the more dangerous, because it cometh without any ill smell, but stealeth on by little and little, inducing only a faintness, without any manifest strangling. When the Dutchmen wintered at Nova Zembla, and that they could gather no more sticks, they fell to make fire of some sea-coal they had, wherewith, at first, they were much refreshed; but a little after they had sat about the fire, there grew a general silence and lothness to speak amongst them; and immediately after, one of the weakest of the company fell down in a swoon; whereupon they doubting what it was, opened their door to let in air, and so saved themselves. The effect, no doubt, is wrought by the inspissation of the air; and so of the breath and spirits. The like ensueth in rooms newly plastered, if a fire be made in them; whereof no less man than the emperor Jovinianus died.

920. Vide the experiment 803, touching the infectious nature of the air, upon the first showers, after a long drought.

921. It hath come to pass, that some apothecaries, upon stamping of colloquintida, have been put into a great scouring by the vapour only.

922. It hath been a practice to burn a pepper they call Guiney-pepper, which hath such a strong spirit, that it provoketh a continual sneezing in those that are in the room.

923. It is an ancient tradition, that blear-eyes infect sound eyes; and that a menstruous woman, looking upon a glass, doth rust it: nay, they have an opinion which seemeth fabulous; that menstruous women going over a field or garden, do corn and herbs good by killing the worms.

924. The tradition is no less ancient, that the basilisk killeth by aspect; and that the wolf, if he see a man first, by aspect striketh a man hoarse.

925. Perfumes convenient do dry and strengthen the brain, and stay rheums and defluxions, as we find in fume of rosemary dried, and lignum aloës; and calamus taken at the mouth and nostrils: and no doubt there be other perfumes that do moisten and refresh, and are fit to be used in burning agues, consumptions, and too much wakefulness: such as are rose-water, vinegar, lemon-peels, violets, the leaves of vines sprinkled with a little rose-water, &c.

926. They do use in sudden faintings and swoonings to put a handkerchief with rose-water or a little vinegar to the nose: which gathereth together again the spirits, which are upon point to resolve and fall away.

927. Tobacco comforteth the spirits, and dischargeth weariness, which it worketh partly by opening, but chiefly by the opiate virtue, which condenseth the spirits. It were good therefore to

try the taking of fumes by pipes, as they do in tobacco, of other things; as well to dry and comfort, as for other intentions. I wish trial be made of the drying fume of rosemary, and lignum aloës, beforementioned, in pipe; and so of nutmeg, and folium indum, &c.

928. The following of the plough hath been approved for refreshing the spirits and procuring appetite; but to do it in the ploughing for wheat or rye, is not so good, because the earth has spent her sweet breath in vegetables put forth in summer. It is better therefore to do it when you sow barley. But because ploughing is tied to seasons, it is best to take the air of the earth new turned up, by digging with the spade, or standing by him that diggeth. Gentlewomen may do themselves much good by kneeling upon a cushion, and weeding. And these things you may practise in the best seasons; which is ever the early spring, before the earth putteth forth the vegetables, and in the sweetest earth you can choose. It would be done also when the dew is a little off the ground, lest the vapour be too moist. I knew a great man that lived long, who had a clean clod of earth brought to him every morning as he sat in his bed: and he would hold his head over it a good pretty while. I commend also, sometimes, in digging of new earth, to pour in some Malmsey or Greek wine, that the vapour of the earth and wine together may comfort the spirits the more; provided always it be not taken for a heathen sacrifice, or libation to the earth.

929. They have in physic use of pomanders, and knots of powders, for drying of rheums, comforting of the heart, provoking of sleep, &c. For though those things be not so strong as perfumes, yet you may have them continually in your hand; whereas perfumes you can take but at times; and besides, there be divers things that breathe better of themselves, than when they come to the fire; as nigella romana, the seed of melanthium, amomum, &c.

930. There be two things which, inwardly used, do cool and condense the spirits; and I wish the same to be tried outwardly in vapours. The one is nitre, which I would have dissolved in Malmsey, or Greek wine, and so the smell of the wine taken; or if you would have it more forcible, pour of it upon a firepan, well heated, as they do rose-water and vinegar. The other is the distilled water of wild poppy, which I wish to be mingled, at half, with rose-water, and so taken with some mixture of a few cloves in a perfuming-pan. The like would be done with the distilled water of saffron flowers.

931. Smells of musk, and amber, and civet, are thought to further venereous appetite; which they may do by the refreshing and calling forth of the spirits.

932. Incense and nidorous smells, such as were of sacrifices, were thought to intoxicate the brain, and to dispose men to devotion: which they may do by a kind of sadness, and contristation of the spirits; and partly also by heating and exalting them. We

see that amongst the Jews the principal perfume of the sanctuary was forbidden all common uses.

933. There be some perfumes prescribed by the writers of natural magic, which procure pleasant dreams: and some others, as they say, that procure prophetical dreams; as the seeds of flax, fleawort, &c.

934. It is certain, that odours do, in a small degree, nourish; especially the odour of wine: and we see men an hungered do love to smell hot bread. It is related that Democritus, when he lay a dying, heard a woman in the house complain that she should be kept from being at a feast and solemnity, which she much desired to see, because there would be a corpse in the house; whereupon he caused loaves of new bread to be sent for, and opened them, and poured a little wine into them; aud so kept himself alive with the odour of them, till the feast was past. I knew a gentleman that would fast, sometimes three or four, yea, five days, without meat, bread, or drink; but the same man used to have continually a great wisp of herbs that he smelled on: and amongst those herbs, some esculent herbs of strong scent; as onions, garlic, leeks, and the like.

935. They do use, for the accident of the mother, to burn feathers and other things of ill odour; and by those ill smells the rising of the mother is put down.

936. There be airs which the physicians advise their patients to remove unto, in consumptions or

upon recovery of long sicknesses: which, commonly, are plain champains, but grazing, and not overgrown with heath or the like; or else timber-shades, as in forests, and the like. It is noted also, that groves of bays do forbid pestilent airs; which was accounted a great cause of the wholesome air of Antiochia. There be also some soils that put forth odorate herbs of themselves; as wild thyme, wild marjoram, pennyroyal, camomile; and in which the brier roses smell almost like musk-roses; which no doubt, are signs that do discover an excellent air.

937. It were good for men to think of having healthful air in their houses; which will never be if the rooms be low-roofed, or full of windows and doors; for the one maketh the air close, and not fresh, and the other maketh it exceeding unequal; which is a great enemy to health. The windows also should not be high up to the roof, which is in use for beauty and magnificence, but low. Also stone-walls are not wholesome; but timber is more wholesome; and especially brick: nay, it hath been used by some with great success to make their walls thick; and to put a lay of chalk between the bricks, to take away all dampishness.

Experiment solitary touching the emissions of spiritual species which affect the senses.

938. These emissions, as we said before, are handled, and ought to be handled by themselves under their proper titles: that is, visibles and audibles, each apart: in this place it shall suffice to give

some general observations common to both. First, they seem to be incorporeal. Secondly, they work swiftly. Thirdly, they work at large distances. Fourthly, in curious varieties. Fifthly, they are not effective of any thing; nor leave no work behind them; but are energies merely: for their working upon mirrours and places of echo doth not alter any thing in those bodies; but it is the same action with the original, only repercussed. And as for the shaking of windows, or rarifying the air by great noises, and the heat caused by burning-glasses; they are rather concomitants of the audible and visible species, than the effects of them. Sixthly, they seem to be of so tender and weak a nature, as they affect only such a rare and attenuate substance, as is the spirit of living creatures.

Experiments in consort touching the emission of immateriate virtues from the minds a nd sirits of men, either by affections, or by imaginations, or by other impressions.

939. It is mentioned in some stories, that where children have been exposed, or taken away young from their parents; and that afterwards they have approached to their parents' presence, the parents, though they have not known them, have had a secret joy or other alteration thereupon.

940. There was an Egyptian soothsayer, that made Antonius believe, that his genius, which otherwise was brave and confident, was, in the presence of Octavianus Cæsar, poor and cowardly: and there-

fore he advised him, to absent himself as much as he could, and remove far from him. This soothsayer was thought to be suborned by Cleopatra, to make him live in Egypt, and other remote places from Rome. Howsoever the conceit of a predominant or mastering spirit of one man over another, is ancient, and received still, even in vulgar opinion.

941. There are conceits, that some men that are of an ill and melancholy nature, do incline the company into which they come to be sad and ill-disposed; and contrariwise, that others that are of a jovial nature, do dispose the company to be merry and cheerful. And again, that some men are lucky to be kept company with and employed; and others unlucky. Certainly, it is agreeable to reason, that there are at the least some light effluxions from spirit to spirit, when men are in presence one with another, as well as from body to body.

942. It hath been observed, that old men who have loved young company, and been conversant continually with them, have been of long life; their spirits, as it seemeth, being recreated by such company. Such were the ancient sophists and rhetoricians; which ever had young auditors and disciples; as Georgias, Protagoras, Isocrates, &c. who lived till they were an hundred years old. And so likewise did many of the grammarians and school-masters; such as was Orbilius, &c.

943. Audacity and confidence doth, in civil business, so great effects, as a man may reasonably doubt, that besides the very daring, and earnestness,

and persisting, and importunity, there should be some secret binding, and stooping of other men's spirits to such persons.

944. The affections, no doubt, do make the spirits more powerful and active; and especially those affections which draw the spirits into the eyes: which are two; love, and envy, which is called oculus malus. As for love, the Platonists, some of them, go so far as to hold that the spirit of the lover doth pass into the spirits of the person loved; which causeth the desire of return into the body whence it was emitted: whereupon followeth that appetite of contact and conjunction which is in lovers. And this is observed likewise, that the aspects which procure love, are not gazings, but sudden glances and dartings of the eye. As for envy, that emitteth some malign and poisonous spirit, which taketh hold of the spirit of another; and is likewise of greatest force when the cast of the eye is oblique. It hath been noted also, that it is most dangerous when an envious eye is cast upon persons in glory, and triumph, and joy. The reason whereof is, for that at such times the spirits come forth most into the outward parts, and so meet the percussion of the envious eye more at hand: and therefore it hath been noted, that after great triumphs, men have been ill-disposed for some days following. We see the opinion of fascination is ancient, for both effects; of procuring love; and sickness caused by envy: and fascination is ever by the eye. But yet if there be any such infection from spirit to spirit, there is no doubt but

that it worketh by presence, and not by the eye alone; yet most forcibly by the eye.

945. Fear and shame are likewise infective; for we see that the starting of one will make another ready to start: and when one man is out of countenance in a company, others do likewise blush in his behalf.

Now we will speak of the force of imagination upon other bodies, and of the means to exalt and strengthen it. Imagination, in this place, I understand to be, the representation of an individual thought. Imagination is of three kinds: the first joined with belief of that which is to come: the second joined with memory of that which is past: and the third is of things present, or as if they were present; for I comprehend in this, imaginations feigned, and at pleasure, as if one should imagine such a man to be in the vestments of a Pope, or to have wings. I single out, for this time, that which is with faith or belief of that which is to come. The inquisition of this subject in our way, which is by induction, is wonderful hard: for the things that are reported are full of fables; and new experiments can hardly be made, but with extreme caution, for the reason which we will hereafter declare.

The power of imagination is of three kinds; the first upon the body of the imaginant, including likewise the child in the mother's womb; the second is, the power of it upon dead bodies, as plants, wood, stone, metal, &c. the third is, the power of it upon

the spirits of men and living creatures: and with this last we will only meddle.

The problem therefore is, whether a man constantly and strongly believing that such a thing shall be, as that such an one will love him, or that such an one will grant him his request, or that such an one shall recover a sickness, or the like, it doth help any thing to the effecting of the thing itself. And here again we must warily distinguish; for it is not meant, as hath been partly said before, that it should help by making a man more stout, or more industrious, in which kind a constant belief doth much, but merely by a secret operation, or binding, or changing the spirit of another: and in this it is hard, as we began to say, to make any new experiment; for I cannot command myself to believe what I will, and so no trial can be made. Nay, it is worse; for whatsoever a man imagineth doubtingly, or with fear, must needs do hurt, if imagination have any power at all; for a man representeth that oftener that he feareth, than the contrary.

The help therefore is, for a man to work by another, in whom he may create belief, and not by himself; until himself have found by experience, that imagination doth prevail; for then experience worketh in himself belief; if the belief that such a thing shall be, be joined with a belief that his imagination may procure it.

946. For example: I related one time to a man that was curious and vain enough in these things, that I saw a kind of juggler, that had a pair of cards, and

would tell a man what card he thought. This pretended learned man told me, it was a mistaking in me; "for," said he, "it was not the knowledge of the man's thought, for that is proper to God, but it was the enforcing of a thought upon him, and binding his imagination by a stronger, that he could think no other card." And thereupon he asked me a question or two, which I thought he did but cunningly, knowing before what used to be the feats of the juggler. "Sir," said he, "do you remember whether he told the card the man thought, himself, or bade another to tell it?" I answered, as was true, that he bade another tell it. Whereunto he said, "So I thought: for," said he, "himself could not have put on so strong an imagination; but by telling the other the card, who believed that the juggler was some strange man, and could do strange things, that other man caught a strong imagination." I hearkened unto him, thinking for a vanity he spoke prettily. Then he asked me another question: saith he, "Do you remember, whether he bade the man think the card first, and afterwards told the other man in his ear what he should think; or else that he did whisper first in the man's ear that should tell the card, telling that such a man should think such a card, and after bade the man think a card?" I told him, as was true; that he did first whisper the man in the ear, that such a man should think such a card: upon this the learned man did much exult and please himself, saying; "Lo, you may see that my opinion is right: for if the man had thought

first, his thought had been fixed; but the other imagining first, bound his thought." Which though it did somewhat sink with me, yet I made it lighter than I thought, and said; I thought it was confederacy between the juggler and the two servants: though, indeed, I had no reason so to think, for they were both my father's servants, and he had never played in the house before. The juggler also did cause a garter to be held up, and took upon him to know, that such an one should point in such a place of the garter, as it should be near so many inches to the longer end, and so many to the shorter; and still he did it, by first telling the imaginer, and after bidding the actor think.

Having told this relation, not for the weight thereof, but because it doth handsomely open the nature of the question, I return to that I said, that experiments of imagination must be practised by others, and not by a man's self. For there be three means to fortify belief: the first is experience; the second is reason; and the third is authority: and that of these which is far the most potent, is authority; for belief upon reason, or experience will stagger.

947. For authority, it is of two kinds, belief in an art, and belief in a man. And for things of belief in an art, a man may exercise them by himself; but for belief in a man, it must be by another. Therefore if a man believe in astrology, and find a figure prosperous, or believe in natural magic, and that a ring with such a stone, or such a piece of a living creature

carried, will do good, it may help his imagination: but the belief in a man is far the more active. But howsoever, all authority must be out of a man's self, turned, as was said, either upon an art, or upon a man: and where authority is from one man to another, there the second must be ignorant, and not learned, or full of thoughts; and such are, for the most part, all witches and superstitious persons, whose beliefs, tied to their teachers and traditions, are no whit controlled either by reason or experience; and upon the same reason, in magic, they use for the most part boys and young people, whose spirits easiliest take belief and imagination.

Now to fortify imagination, there be three ways: the authority whence the belief is derived; means to quicken and corroborate the imagination; and means to repeat it and refresh it.

948. For the authority, we have already spoken: as for the second, namely, the means to quicken and corroborate the imagination; we see what hath been used in magic, if there be in those practices any thing that is purely natural, as vestments, characters, words, seals; some parts of plants, or living creatures; stones, choice of the hour, gestures and motions; also incenses and odours, choice of society, which increaseth imagination; diets and preparations for some time before. And for words, there have been ever used, either barbarous words, of no sense, lest they should disturb the imagination, or words of similitude, that may second and feed the imagination; and this was ever as well in heathen charms, as in charms

of latter times. There are used also Scripture words; for that the belief that religious texts and words have power, may strengthen the imagination. And for the same reason, Hebrew words, which amongst us is counted the holy tongue, and the words more mystical, are often used.

949. For the refreshing of the imagination, which was the third means of exalting it, we see the practices of magic, as in images of wax, and the like, that should melt by little and little; or some other things buried in muck, that should putrify by little and little; or the like: for so oft as the imaginant doth think of those things, so oft doth he represent to his imagination the effect of that he desireth.

950. If there be any power in imagination, it is less credible that it should be so incorporeal, and immateriate a virtue, as to work at great distances, or through all mediums, or upon all bodies: but that the distance must be competent, the medium not adverse, and the body apt and proportionate. Therefore if there be any operation upon bodies in absence by nature, it is like to be conveyed from man to man, as fame is; as if a witch, by imagination, should hurt any afar off, it cannot be naturally; but by working upon the spirit of some that cometh to the witch; and from that party upon the imagination of another; and so upon another; till it come to one that hath resort to the party intended; and so by him to the party intended himself. And although they speak, that it sufficeth to take a point, or a piece of the garment, or the name of the party, or the like; yet

there is less credit to be given to those things, except it be by working of evil spirits.

The experiments, which may certainly demonstrate the power of imagination upon other bodies, are few or none: for the experiments of witchcraft are no clear proofs; for that they may be by a tacit operation of malign spirits: we shall therefore be forced, in this inquiry, to resort to new experiments; wherein we can give only directions of trials, and not any positive experiments. And if any man think that we ought to have stayed till we had made experiment of some of them ourselves, as we do commonly in other titles, the truth is, that these effects of imagination upon other bodies have so little credit with us, as we shall try them at leisure: but in the mean time we will lead others the way.

951. When you work by the imagination of another, it is necessary that he, by whom you work, have a precedent opinion of you that you can do strange things; or that you are a man of art, as they call it; for else the simple affirmation to another, that this or that shall be, can work but a weak impression in his imagination.

952. It were good, because you cannot discern fully of the strength of imagination in one man more than another, that you did use the imagination of more than one, that so you may light upon a strong one. As if a physician should tell three or four of his patient's servants, that their master shall surely recover.

953. The imagination of one that you shall use, such is the variety of men's minds, cannot be always

alike constant and strong; and if the success follow not speedily, it will faint and lose strength. To remedy this, you must pretend to him, whose imagination you use, several degrees of means, by which to operate: as to prescribe him that every three days, if he find not the success apparent, he do use another root, or part of a beast, or ring, &c. as being of more force; and if that fail, another; and if that, another, till seven times. Also you must prescribe a good large time for the effect you promise; as if you should tell a servant of a sick man that his master shall recover, but it will be fourteen days ere he findeth it apparently, &c. All this to entertain the imagination that it waver less.

954. It is certain, that potions, or things taken into the body; incenses and perfumes taken at the nostrils; and ointments of some parts, do naturally work upon the imagination of him that taketh them. And therefore it must needs greatly co-operate with the imagination of him whom you use, if you prescribe him, before he do use the receipt for the work which he desireth, that he do take such a pill, or a spoonful of liquor; or burn such an incense; or anoint his temples, or the soles of his feet, with such an ointment or oil: and you must choose, for the composition of such pill, perfume, or ointment, such ingredients as do make the spirits a little more gross or muddy; whereby the imagination will fix the better.

955. The body passive, and to be wrought upon, I mean not of the imaginant, is better wrought upon, as hath been partly touched, at some times than at

others: as if you should prescribe a servant about a sick person, whom you have possessed that his master shall recover, when his master is fast asleep, to use such a root, or such a root. For imagination is like to work better upon sleeping men, than men awake; as we shall shew when we handle dreams.

956. We find in the art of memory, that images visible work better than other conceits: as if you would remember the word philosophy, you shall more surely do it, by imagining, that such a man, for men are best places, is reading upon Aristotle's Physics; than if you should imagine him to say, "I'll go study philosophy." And therefore this observation would be translated to the subject we now speak of: for the more lustrous the imagination is, it filleth and fixeth the better. And therefore I conceive, that you shall, in that experiment whereof we spake before, of binding of thoughts, less fail, if you tell one that such an one shall name one of twenty men, than if it were one of twenty cards. The experiment of binding of thoughts would be diversified and tried to the full: and you are to note, whether it hit for the most part, though not always.

957. It is good to consider, upon what things imagination hath most force: and the rule, as I conceive, is, that it hath most force upon things that have the lightest and easiest motions. And therefore above all, upon the spirits of men: and in them, upon such affections as move lightest; as upon procuring of love; binding of lust, which is ever with imagination; upon men in fear; or men in irresolution; and

the like. Whatsoever is of this kind would be throughly inquired. Trials likewise would be made upon plants, and that diligently: as if you should tell a man, that such a tree would die this year; and will him at these and these times to go unto it, to see how it thriveth. As for inanimate things, it is true that the motions of shuffling of cards, or casting of dice, are very light motions: and there is a folly very usual, that gamesters imagine, that some that stand by them bring them ill luck. There would be trial also made, of holding a ring by a thread in a glass, and telling him that holdeth it, before, that it shall strike so many times against the side of the glass, and no more; or of holding a key between two men's fingers, without a charm; and to tell those that hold it, that at such a name it shall go off their fingers; for these two are extreme light motions. And howsoever I have no opinion of these things, yet so much I conceive to be true; that strong imagination hath more force upon things living, or that have been living, than things merely inanimate: and more force likewise upon light and subtile motions, than upon motions vehement or ponderous.

958. It is an usual observation, that if the body of one murdered be brought before the murderer, the wounds will bleed afresh. Some do affirm, that the dead body, upon the presence of the murderer, hath opened the eyes; and that there have been such like motions, as well where the parties murdered have been strangled or drowned, as where they have been killed by wounds. It may be, that this parti-

cipateth of a miracle, by God's just judgment, who usually bringeth murders to light: but if it be natural, it must be referred to imagination.

959. The tying of the point upon the day of marriage, to make men impotent towards their wives, which, as we have formerly touched, is so frequent in Zant and Gascony, if it be natural, must be referred to the imagination of him that tieth the point. I conceive it to have the less affinity with witchcraft, because not peculiar persons only, such as witches are, but any body may do it.

Experiments in consort touching the secret virtue of sympathy and antipathy.

960. There be many things that work upon the spirits of man by secret sympathy and antipathy: the virtues of precious stones worn, have been anciently and generally received, and curiously assigned to work several effects. So much is true; that stones have in them fine spirits, as appeareth by their splendour; and therefore they may work by consent upon the spirits of men, to comfort and exhilarate them. Those that are the best, for that effect, are the diamond, the emerald, the jacinth oriental, and the gold stone, which is the yellow topaz. As for their particular properties, there is no credit to be given to them. But it is manifest, that light, above all things, excelleth in comforting the spirits of men: and it is very probable, that light varied [illegible] same effect, with more novelty. And this is o[illegible] of the causes why precious stones comfort.

And therefore it were good to have tincted lanthorns, or tincted screens of glass coloured into green blue, carnation, crimson, purple, &c. and to use them with candles in the night. So likewise to have round glasses, not only of glass coloured through, but with colours laid between crystals, with handles to hold in one's hand. Prisms are also comfortable things. They have of Paris-work, looking-glasses, bordered with broad borders of small crystal, and great counterfeit precious stones, of all colours, that are most glorious and pleasant to behold; especially in the night. The pictures of Indian feathers are likewise comfortable and pleasant to behold. So also fair and clear pools do greatly comfort the eyes and spirits, especially when the sun is not glaring, but over-cast; or when the moon shineth.

961. There be divers sorts of bracelets fit to comfort the spirits; and they be of three intentions; refrigerant, corroborant, and aperient. For refrigerant, I wish them to be of pearl, or of coral, as is used; and it hath been noted that coral, if the party that weareth it be indisposed, will wax pale; which I believe to be true, because otherwise distemper of heat will make coral lose colour. I commend also beads, or little plates of lapis lazuli; and beads of nitre, either alone, or with some cordial mixture.

962. For corroboration and confortation, take such bodies as are of astringent quality, without manifest cold. I commend bead-amber, which is full of astriction, but yet is unctuous, and not cold; and

is conceived to impinguate those that wear such beads; I commend also beads of hartshorn and ivory; which are of the like nature; also orange beads; also beads of lignum aloës, macerated first in rose-water, and dried.

963. For opening, I commend beads, or pieces of the roots of carduus benedictus: also of the roots of piony the male; and of orrice; and of calamus aromaticus; and of rue.

964. The cramp, no doubt, cometh of contraction of sinews; which is manifest, in that it cometh either by cold or dryness; as after consumptions, and long agues; for cold and dryness do, both of them, contract and corrugate. We see also, that chafing a little above the place in pain, easeth the cramp; which is wrought by the dilatation of the contracted sinews by heat. There are in use, for the prevention of the cramp, two things; the one rings of sea-horse teeth worn upon the fingers; the other bands of green periwinkle, the herb, tied about the calf of the leg, or the thigh, &c. where the cramp useth to come. I do find this the more strange, because neither of these have any relaxing virtue, but rather the contrary. I judge therefore, that their working is rather upon the spirits, within the nerves, to make them strive less, than upon the bodily substance of the nerves.

965. I would have trial made of two other kinds of bracelets, for comforting the heart and spirits: the one of the trochisk of vipers, made into little pieces of beads; for since they do great good in-

wards, especially for pestilent agues, it is like they will be effectual outwards; where they may be applied in greater quantity. There would be trochisk likewise made of snakes; whose flesh dried is thought to have a very opening and cordial virtue. The other is, of beads made of the scarlet powder, which they call kermes; which is the principal ingredient in their cordial confection alkermes: the beads would be made up with ambergrease, and some pomander.

966. It hath been long received, and confirmed by divers trials, that the root of the male-piony dried, tied to the neck, doth help the falling sickness; and likewise the incubus, which we call the mare. The cause of both these diseases, and especially of the epilepsy from the stomach, is the grossness of the vapours which rise and enter into the cells of the brain: and therefore the working is by extreme and subtile attenuation; which that simple hath. I judge the like to be in castoreum, musk, rue-seed, agnus castus seed, &c.

967. There is a stone which they call the blood-stone, which worn is thought to be good for them that bleed at the nose: which no doubt, is by astriction and cooling of the spirits. *Query*, if the stone taken out of the toad's head, be not of the like virtue; for the toad loveth shade and coolness.

968. Light may be taken from the experiment of the horse-tooth ring, and the garland of periwinkle, how that those things which assuage the strife of the spirits, do help diseases contrary to the intention desired: for in the curing of the cramp,

the intention is to relax the sinews; but the contraction of the spirits, that they strive less, is the best help: so to procure easy travails of women, the intention is to bring down the child; but the best help is, to stay the coming down too fast: whereunto they say, the toad-stone likewise helpeth. So in pestilent fevers, the intention is to expel the infection by sweat and evaporation: but the best means to do it is by nitre diascordium, and other cool things, which do for a time arrest the expulsion, till nature can do it more quietly. For as one saith prettily; "In the quenching of the flame of a pesti- "lent ague, nature is like people that come to quench "the fire of a house; which are so busy, as one of "them letteth another." Surely it is an excellent axiom, and of manifold use, that whatsoever appeaseth the contention of the spirits, furthereth their action.

969. The writers of natural magic commend the wearing of the spoil of a snake, for preserving of health. I doubt it is but a conceit; for that the snake is thought to renew her youth, by casting her spoil. They might as well take the beak of an eagle, or a piece of a hart's horn because those renew.

970. It hath been anciently received, for Pericles the Athenian used it, and it is yet in use, to wear little bladders of quicksilver, or tablets of arsenic, as preservatives against the plague: not as they conceive for any comfort they yield to the spirits, but for that being poisons themselves, they draw the venom to them from the spirits.

971. Vide the experiments 95, 96, and 97, touching the several sympathies and antipathies for medicinal use.

972. It is said, that the guts or skin of a wolf, being applied to the belly, do cure the colic. It is true, that the wolf is a beast of great edacity and digestion; and so it may be the parts of him comfort the bowels.

973. We see scare-crows are set up to keep birds from corn and fruit; it is reported by some, that the head of a wolf, whole, dried, and hanged up in a dove-house, will scare away vermin; such as are weasles, pole-cats, and the like. It may be the head of a dog will do as much; for those vermin with us, know dogs better than wolves.

974. The brains of some creatures, when their heads are roasted, taken in wine, are said to strengthen the memory; as the brains of hares, brains of hens, brains of deers, &c. And it seemeth to be incident to the brains of those creatures that are fearful.

975. The ointment that witches use, is reported to be made of the fat of children digged out of their graves; of the juices of smallage, wolf-bane, and cinque-foil, mingled with the meal of fine wheat. But I suppose, that the soporiferous medicines are likest to do it; which are henbane, hemlock, mandrake, moonshade, tobacco, opium, saffron, poplar-leaves, &c.

976. It is reported by some, that the affections of beasts when they are in strength do add some

virtue unto inanimate things; as that the skin of a sheep devoured by a wolf, moveth itching; that a stone bitten by a dog in anger, being thrown at him, drunk in powder, provoketh choler.

977. It hath been observed, that the diet of women with child doth work much upon the infant; as if the mother eat quinces much, and coriander-seed, the nature of both which is to repress and stay vapours that ascend to the brain, it will make the child ingenious; and on the contrary side, if the mother eat much onions or beans, or such vaporous food; or drink wine or strong drink immoderately; or fast much; or be giving to much musing; all which send or draw vapours to the head: it endangereth the child to become lunatic, or of imperfect memory: and I make the same judgment of tobacco often taken by the mother.

978. The writers of natural magic report, that the heart of an ape, worn near the heart, comforteth the heart, and increaseth audacity. It is true that the ape is a merry and bold beast. And that the same heart likewise of an ape, applied to the neck or head, helpeth the wit; and is good for the falling sickness: the ape also is a witty beast, and hath a dry brain; which may be some cause of attenuation of vapours in the head. Yet it is said to move dreams also. It may be the heart of a man would do more, but that it is more against men's minds to use it; except it be in such as wear the reliques of saints.

979. The flesh of a hedge-hog, dressed and eaten,

is said to be a great drier: it is true that the juice of a hedge-hog must needs be harsh and dry, because it putteth forth so many prickles: for plants also that are full of prickles are generally dry; as briers, thorns, berberries; and therefore the ashes of an hedge-hog are said to be a great desiccative of fistulas.

980. Mummy hath great force in stanching of blood; which, as it may be ascribed to the mixture of balms that are glutinous; so it may also partake of a secret propriety, in that the blood draweth man's flesh. And it is approved that the moss which groweth upon the skull of a dead man unburied, will stanch blood potently: and so do the dregs, or powder of blood, severed from the water, and dried.

981. It hath been practised, to make white swallows, by anointing of the eggs with oil. Which effect may be produced, by the stopping of the pores of the shell, and making the juice that putteth forth the feathers afterwards more penurious. And it may be, the anointing of the eggs will be as effectual as the anointing of the body; of which vide the experiment 93.

982. It is reported, that the white of an egg, or blood, mingled with salt-water, doth gather the saltness, and maketh the water sweeter. This may be by adhesion; as in the sixth experiment of clarification: it may be also, that blood, and the white of an egg, which is the matter of a living creature, have some sympathy with salt: for all life hath a sympathy with salt. We see that salt laid to a cut finger

healeth it; so as it seemeth salt draweth blood, as well as blood draweth salt.

983. It hath been anciently received, that the sea air hath an antipathy with the lungs, if it cometh near the body, and erodeth them. Whereof the cause is conceived to be, a quality it hath of heating the breath and spirits, as cantharides have upon the watery parts of the body, as urine and hydropical water. And it is a good rule, that whatsoever hath an operation upon certain kinds of matters, that, in man's body, worketh most upon those parts wherein that kind of matter aboundeth.

984. Generally, that which is dead, or corrupted, or excerned, hath antipathy with the same thing when it is alive, and when it is sound; and with those parts which do excern: as a carcase of man is most infectious and odious to man; a carrion of an horse to an horse, &c. purulent matter of wounds, and ulcers, carbuncles, pocks, scabs, leprosy, to sound flesh, and the excrement of every species to that creature that excerneth them: but the excrements are less pernicious than the corruptions.

985. It is a common experience, that dogs know the dog-killer; when, as in times of infection, some petty fellow is sent out to kill the dogs; and that though they have never seen him before, yet they will all come forth, and bark, and fly at him.

986. The relations touching the force of imagination, and the secret instincts of nature, are so uncertain, as they require a great deal of examination ere we conclude upon them. I would have it first

thoroughly inquired, whether there be any secret passages of sympathy between persons of near blood, as parents, children, brothers, sisters, nurse-children, husbands, wives, &c, There be many reports in history, that upon the death of persons of such nearness, men have had an inward feeling of it. I myself remember, that being in Paris, and my father dying in London, two or three days before my father's death, I had a dream, which I told to divers English gentlemen, that my father's house in the country was plastered all over with black mortar. There is an opinion abroad, whether idle or no I cannot say, that loving and kind husbands have a sense of their wives breeding children, by some accident in their own body.

987. Next to those that are near in blood, there may be the like passage, and instincts of nature between great friends and enemies: and sometimes the revealing is unto another person, and not to the party himself. I remember Phillippus Commineus, a grave writer, reporteth, that the archbishop of Vienna, a reverend prelate, said one day after mass to king Lewis the eleventh of France: "Sir, your mortal enemy is dead;" what time duke Charles of Burgundy was slain at the battle of Granson against the Switzers. Some trial also would be made, whether pact or agreement do any thing; as if two friends should agree, that such a day in every week, they, being in far distant places, should pray one for another, or should put on a ring or tablet one for another's sake; whether if one of them should break

their vow and promise, the other should have any feeling of it in absence.

988. If there be any force in imaginations and affections of singular persons, it is probable the force is much more in the joint imaginations and affections of multitudes: as if a victory should be won or lost in remote parts, whether is there not some sense thereof in the people whom it concerneth, because of the great joy or grief that many men are possessed with at once? Pius Quintus, at the very time when that memorable victory was won by the Christians against the Turks, at the naval battle of Lepanto, being then hearing of causes in consistory, brake off suddenly, and said to those about him, "It is now more time we should give thanks to God, for the great victory he hath granted us against the Turks:" it is true, that victory had a sympathy with his spirit; for it was merely his work to conclude that league. It may be that revelation was divine: but what shall we say then to a number of examples amongst the Grecians and Romans? where the people being in theatres at plays, have had news of victories and overthrows, some few days before any messenger could come.

It is true, that that may hold in these things, which is the general root of superstition: namely, that men observe when things hit, and not when they miss; and commit to memory the one, and forget and pass over the other. But touching divination, and the misgiving of minds, we shall speak

more when we handle in general the nature of minds, and souls, and spirits.

989. We have given formerly some rules of imagination; and touching the fortifying of the same. We have set down also some few instances and directions, of the force of imagination upon beasts, birds, &c. upon plants, and upon inanimate bodies: wherein you must still observe, that your trials be upon subtle and light motions, and not the contrary; for you will sooner by imagination bind a bird from singing than from eating or flying: and I leave it to every man to choose experiments which himself thinketh most commodious, giving now but a few examples of every of the three kinds.

990. Use some imaginant, observing the rules formerly prescribed, for binding of a bird from singing, and the like of a dog from barking. Try also the imagination of some, whom you shall accommodate with things to fortify it, in cock-fights, to make one cock more hardy, and the other more cowardly. It would be tried also in flying of hawks, or in coursing of a deer, or hare, with greyhounds: or in horse-races, and the like comparative motions; for you may sooner by imagination quicken or slack a motion, than raise or cease it; as it is easier to make a dog go slower, than to make him stand still, that he may not run.

991. In plants also you may try the force of imagination upon the lighter sort of motions: as upon the sudden fading, or lively coming up of herbs, or

upon their bending one way or other; or upon their closing and opening, &c.

992. For inanimate things, you may try the force of imagination, upon staying the working of beer when the barm is put in, or upon the coming of butter or cheese, after the churning, or the rennet be put in.

993. It is an ancient tradition every where alleged, for example of secret proprieties and influxes, that the torpedo marina, if it be touched with a long stick, doth stupefy the hand of him that toucheth it. It is one degree of working at distance, to work by the continuance of a fit medium, as sound will be conveyed to the ear by striking upon a bow-string, if the horn of the bow be held to the ear.

994. The writers of natural magic do attribute much to the virtues that come from the parts of living creatures, so as they be taken from them, the creatures remaining still alive: as if the creatures still living did infuse some immateriate virtue and vigour into the part severed. So much may be true; that any part taken from a living creature newly slain, may be of greater force than if it were taken from the like creature dying of itself, because it is fuller of spirit.

995. Trial would be made of the like parts of individuals in plants and living creatures; as to cut off a stock of a tree, and to lay that which you cut off to putrify, to see whether it will decay the rest of the stock: or if you should cut off part of the tail or leg of a dog or a cat, and lay it to putrify, and so see

whether it will fester, or keep from healing, the part which remaineth.

996. It is received, that it helpeth to continue love, if one wear a ring, or a bracelet, of the hair of the party beloved. But that may be by the exciting of the imagination: and perhaps a glove, or other like favour, may as well do it.

997. The sympathy of individuals, that have been entire, or have touched, is of all others the most incredible; yet according unto our faithful manner of examination of nature, we will make some little mention of it. The taking away of warts, by rubbing them with somewhat that afterwards is put to waste and consume, is a common experiment; and I do apprehend it the rather because of my own experience. I had from my childhood a wart upon one of my fingers: afterwards, when I was about sixteen years old, being then at Paris, there grew upon both my hands a number of warts, at the least an hundred, in a month's space. The English ambassador's lady, who was a woman far from superstition, told me one day, she would help me away with my warts: whereupon she got a piece of lard with the skin on, and rubbed the warts all over with fat side; and amongst the rest, that wart which I had had from my childhood: then she nailed the piece of lard, with the fat towards the sun, upon a post of her chamber window, which was to the south. The success was, that within five weeks' space all the warts went quite away: and that wart which I had so long endured, for company. But at the rest I did little marvel,

because they came in a short time, and might go away in a short time again: but the going away of that which had stayed so long doth yet stick with me. They say the like is done by the rubbing of warts with a green elder stick, and then burying the stick to rot in muck. It would be tried with corns and wens, and such other excrescences. I would have it also tried with some parts of living creatures that are nearest the nature of excrescences; as the combs of cocks, the spurs of cocks, the horns of beasts, &c. And I would have it tried both ways; both by rubbing those parts with lard, or elder, as before, and by cutting off some piece of those parts, and laying it to consume: to see whether it will work any effect towards the consumption of that part which was once joined with it.

998. It is constantly received and avouched, that the anointing of the weapon that maketh the wound, will heal the wound itself. In this experiment, upon the relation of men of credit, though myself, as yet, am not fully inclined to believe it, you shall note the points following: first, the ointment wherewith this is done is made of divers ingredients; whereof the strangest and hardest to come by, are the moss upon the skull of a dead man unburied, and the fats of a boar and a bear killed in the act of generation. These two last I could easily suspect to be prescribed as a starting-hole: that if the experiment proved not, it might be pretended that the beasts were not killed in the due time; for as for the moss, it is certain there is great quantity of it in Ireland, upon slain

bodies, laid on heaps unburied. The other ingredients are, the blood-stone in powder, and some other things, which seem to have a virtue to stanch blood; as also the moss hath. And the description of the whole ointment is to be found in the chemical dispensatory of Crollius. Secondly, the same kind of ointment applied to the hurt itself worketh not the effect; but only applied to the weapon. Thirdly, which I like well, they do not observe the confecting of the ointment under any certain constellation; which commonly is the excuse of magical medicines when they fail, that they were not made under a fit figure of heaven. Fourthly, it may be applied to the weapon, though the party hurt be at great distance. Fifthly, it seemeth the imagination of the party to be cured is not needful to concur; for it may be done without the knowledge of the party wounded: and thus much has been tried, that the ointment, for experiment's sake, hath been wiped off the weapon, without the knowledge of the party hurt, and presently the party hurt hath been in great rage of pain, till the weapon was re-anointed. Sixthly, it is affirmed, that if you cannot get the weapon, yet if you put an instrument of iron or wood, resembling the weapon, into the wound, whereby it bleedeth, the anointing of that instrument will serve and work the effect. This I doubt should be a device to keep this strange form of cure in request and use; because many times you cannot come by the weapon itself. Seventhly, the wound must be at first washed clean with white wine, or the party's

own water; and then bound up close in fine linen, and no more dressing renewed till it be whole. Eighthly, the sword itself must be wrapped up close, as far as the ointment goeth, that it taketh no wind. Ninthly, the ointment, if you wipe it off from the sword and keep it, will serve again; and rather increase in virtue than diminish. Tenthly, it will cure in far shorter time than ointments of wounds commonly do. Lastly, it will cure a beast, as well as a man, which I like best of all the rest, because it subjecteth the matter to an easy trial.

Experiment solitary touching secret properties.

999. I would have men know, that though I reprehend the easy passing over the causes of things, by ascribing them to secret and hidden virtues, and proprieties, for this hath arrested and laid asleep all true inquiry and indications, yet I do not understand, but that in the practical part of knowledge, much will be left to experience and probation, whereunto indication cannot so fully reach: and this not only in specie, but in individuo. So in physic; if you will cure the jaundice, it is not enough to say, that the medicine must not be cooling; for that will hinder the opening which the disease requireth: that it must not be hot; for that will exasperate choler: that it must go to the gall; for there is the obstruction which causeth the disease, &c. But you must receive from experience that powder of Chamœpytis, or the like, drunk in beer, is good for the jaundice. So again a wise physician doth not con-

tinue still the same medicine to a patient; but he will vary, if the first medicine doth not apparently succeed: for of those remedies that are good for the jaundice, stone, agues, &c. that will do good in one body which will not do good in another; according to the correspondence the medicine hath to the individual body.

Experiment solitary touching the general sympathy of men's spirits.

1000. The delight which men have in popularity, fame, honour, submission, and subjection of other men's minds, wills, or affections, although these things may be desired for other ends, seemeth to be a thing in itself without contemplation of consequence, grateful and agreeable to the nature of man. This thing, surely, is not without some signification, as if all spirits and souls of men came forth out of one divine limbus; else why should men be so much affected with that which others think or say? The best temper of minds desireth good name and true honour: the lighter, popularity and applause: the more depraved, subjection and tyranny; as is seen in great conquerors and troublers of the world: and yet more in arch-heretics; for the introducing of new doctrines is likewise an affectation of tyranny over the understandings and beliefs of men.

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